TAXONOMY AND DISTRIBUTION OF SEA ANEMONES (CNIDARIA: ACTINIARIA, CORALLIMORPHARIA) FROM DEEP WATER OF THE NORTHEASTERN PACIFIC

BY

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Abstract

Little is known about the taxonomy and distribution of the sea anemones *sensu lato* (animals belonging to cnidarian orders Actiniaria and Corallimorpharia) of the deep northeastern Pacific Ocean. I estimate that there are approximately 32 actiniarian and 2 corallimorpharian species in the deep sea of the northeastern Pacific, and fewer than half are known to science. I identified, using morphological characters, 14 of the largest and most abundant epibenthic deep-sea anemones including 12 actiniarians (of which three are new species) and 2 corallimorpharians, and determined each species' distribution. Half of the species, *Corallimorphus pilatus* Fautin, White, and Pearson, 2002, *Corallimorphus denhartogi* Fautin, White, and Pearson, 2002, *Anthosactis nomados* White, Wakefield Pagels, and Fautin, 1999, *Bolocera kensmithi* n. sp., *Paraphelliactis pabista* Dunn, 1982, *Sagartiogeton californicus* (Carlgren, 1940), and *Sicyonis careyi* n. sp., have been collected only in the northeastern Pacific Ocean. The remaining species, *Actinauge verrillii* McMurrich, 1893, *Actinoscyphia groendyki* n. sp., *Bathyphellia australis* Dunn, 1983, *Liponema brevicorne* (McMurrich, 1893), *Metridium farcimen* (Brandt, 1835), *Monactis vestita* (Gravier, 1918), and *Paractinostola faeculenta* (McMurrich, 1893), are widely distributed. In the northeastern Pacific, a naturally occurring oxygen minimum zone (OMZ) off Oregon currently extends from near the shore to at least 1,200 m. It is now expanding and contains areas of virtually no oxygen, therefore threatening the marine life living within it. Nine of the species I examined (*Corallimorphus pilatus*, *Anthosactis nomados*, *Actinauge verrillii*, *Actinoscyphia groendyki* n. sp., *Liponema brevicorne*, *Metridium farcimen*, *Paractinostola faeculenta*, *Sagartiogeton californicus* and *Sicyonis careyi* n. sp.) occur within the current depth

range of the OMZ. Although cnidarians are tolerant of low oxygen concentrations, they cannot survive if there is no oxygen; therefore, individuals of those nine species may be threatened as the OMZ continues to strengthen and expand. The inventory of the deep-sea anemones of the northeastern Pacific that I created can be used in the future to compare with inventories of anemones from within the OMZ to determine if the OMZ has had an effect on the anemones that should occupy that depth range.

Acknowledgements

I acknowledge the members of my thesis committee, Drs. Caroline Chaboo and Kirsten Jensen, for their support and guidance throughout my time at the University of Kansas. I thank my advisor, Dr. Daphne Fautin, for not only teaching me about sea anemone taxonomy, but also about how to be a scientist.

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Shawn Saving from the Kansas Geological Survey taught me how to create maps using ArcInfo, and provided me with useful tips on how best to present my distribution data. I greatly appreciate his patience and willingness to help me learn a program that was like a foreign language to me.

My family and friends deserve the most gratitude. My amazing husband, Kyle Loucks, has been my strength, has been my biggest cheerleader, and has supported my move to the middle of the country to study marine biology. Kyle and my officemate,

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Introduction

The sea anemones *sensu lato* (animals belonging to cnidarian orders Actiniaria and Corallimorpharia) of the deep northeastern Pacific Ocean are poorly studied; in contrast, much is known about the approximately 30 species of intertidal sea anemones of the northeastern Pacific and their distributions (*e.g.* Gotshall 1994; Fautin and Hand 2007). Only 14 of what I estimate to be at least 34 species that occur in the northeastern Pacific, from approximately 1,000 m and deeper, are known to science; most have been described in short papers on only one or two species (*e.g.* Dunn 1982; White *et al.* 1999; Fautin *et al.* 2002), and no inventory of the fauna has been made.

I have created a baseline of the epibenthic anemone fauna of the northeastern Pacific and determined each species' range not only because of the lack of knowledge about the fauna, but also because a naturally occurring oxygen minimum zone (OMZ) is growing off the coast of Oregon and possess a threat to animals occurring within it. A baseline of the anemone fauna of the deep northeastern Pacific can be used in the future to determine if the anemone fauna has been affected by the OMZ's expansion.

To establish this baseline, I used morphological characters to identify 14 of the most abundant and conspicuous species of deep-sea anemones (12 actiniarians and 2 corallimorpharians) collected along the continental slope and abyssal plain from California to British Columbia mostly during the 1960s and 1970s. The specimens I examined are held at CAS, KUBI, RBCM, SBMNH, and USNM (see Appendix 1 for details on repositories). By examining specimens collected throughout the northeastern Pacific, I was able to determine the ranges of each species including which ones occur within the same depth as the OMZ.

Oxygen Minimum Zones. The average concentration of dissolved oxygen (DO) within ocean surface waters is 6-8 ml/L (Gewin 2010); however, OMZs contain concentrations of DO from 0.5 ml/L (severe hypoxia) to virtually no oxygen (anoxia) (Chan *et al.* 2008; Gewin 2010). OMZs occur below the photic zone in areas where there is high oxygen consumption and minimal oxygen exchange between layers of water (Wyrtki 1962); such zones of low oxygen can occur naturally or arise because of human activities.

OMZs occur naturally along western continental coasts, such as off Oregon, due to the combination of nutrient upwelling and carbon respiration. Winds drive nutrient-rich deep water to the surface, where the nutrients fuel algal growth in the photic zone. Organic carbon from the oxygen-rich and productive surface layer sinks into intermediate waters (~400 and 1,500 m in the northeastern Pacific Ocean [Swan *et al.* 2009]); as the carbon is respired, dissolved oxygen is depleted from the water (Hales *et al.* 2006).

The effects of anthropogenic activities, such as global warming, are decreasing DO in oxygen-poor intermediate waters (Keeling and Garcia 2002). Global warming heats the sea surface and intensifies natural stratification in the layers of the ocean, preventing highly oxygenated surface waters from mixing with oxygen-depleted deeper layers (Keeling and Garcia 2002). Further decreases in DO within and near OMZs around the world are predicted by climate models (Matear and Hirst 2003).

OMZs off the west coast of North America have been known for several decades (Kamykowski and Zentara 1990). Recently the OMZ along the coast of Oregon, which naturally occurs from a depth of ~600 m to ~1,200 m, has begun to expand along the continental shelf to a depth of less than 50 m; for the first time it contains areas of

seasonally persistent anoxia, and oxygen concentrations of less than 0.5 ml/L are now common along the continental shelf and slope (Chan *et al.* 2008; Gewin 2010).

Benthic invertebrates and slow-swimming fishes are less likely to be able to escape from low-oxygen conditions than fast-swimming fishes; therefore, these animals are at risk of dying as DO concentrations off the coast of Oregon continue to decrease. Most of the macroscopic benthic invertebrates sampled along shelf transects within the OMZ off the coast of Oregon in 2006 were dead as a result of decreased oxygen (Chan *et al.* 2008).

Members of the phylum Cnidaria, which include sea anemones, have high tolerance to hypoxic conditions (less than ~1.4 ml/L [2.0 mg/L] DO); on average, cnidarians can survive at DO concentrations of 0.48 ml/L [0.69 mg/L], which is lower than the oxygen concentration at which almost all polychaetes, mollusks, echinoderms, crustaceans, and fishes can survive (Vaquer-Sunyer and Duarte 2008). Because DO has been reduced to zero in some places, I infer that even animals such as sea anemones that have high tolerance to hypoxia may be dying. In the future, the baseline of the deep-sea northeastern Pacific anemones I established from specimens collected decades ago can be compared to the existing fauna to determine if the expansion of the OMZ has affected the diversity of anemones; if the anemones are dead, it is likely that other less hypoxia-tolerant benthic invertebrates such as echinoderms, mollusks, and crustaceans are dead as well.

Similarities with other fauna. Although knowing the composition of the anemone fauna from the time before the expansion of the OMZ is important, it is equally important to

know each species' distribution. Those species that occur near intermediate waters, especially off the coast of Oregon, may be threatened as the OMZ continues to expand. I studied the ranges of the 14 northeastern Pacific species to determine their geographic and bathymetric distribution.

Connectivity of deep-water results in faunal similarities. The deep sea, which includes the bathyal, abyssal, and hadal zones (see Figure 1; the hadal zone is deeper than 6,000 m and not pictured), is the largest habitat on earth, and 84% of the area of the ocean bottom lies below 2,000 m (Brunn 1956). Within the deep sea, many benthic invertebrates appear to be widespread; Ekman (1953) noted that much of the abyssal fauna has a widespread distribution and Vinogradova (1959), in analyzing 1,031 species from around the world at deeper than 2,000 m, found that at the generic level faunas are similar, but endemicity is high at the species level. The high degree of similarity between deep-sea genera in different oceans is likely due to increasing connectivity of water, and therefore homogeneity of the environment, with depth.

Although the deep water is continuous, the deep sea is not all homogenous. The topology shallower than 2,000 m is more complex and the temperature and salinity are more variable than below 2,000 m (Gage and Tyler 1992; Etter *et al.* 2005); therefore, the bathyal zone (defined here as the shelf break [~200 m] to 2,000 m) is more heterogeneous than the rest of the deep sea. Populations and faunas that occupy the bathyal zone, as a result, are likely to be more heterogeneous than those that occupy the abyssal zone (defined here as 2,000 m to 6,000 m); for example, Etter *et al.* (2005) found lower levels

of divergence in populations of bivalve species from approximately 3,000 to 5,000 m than in shallower water.

The abyssal zone is much more homogeneous than the bathyal zone; the bottom is muddy and mostly flat, and the water is cold and salty. Along transects taken in the Atlantic, Pacific, and Indian oceans between 2,000 m and 6,000 m the water varied between approximately -1.2 and 3.4°C and 34.6 and 35.0‰ (Mantyla and Reid 1983).

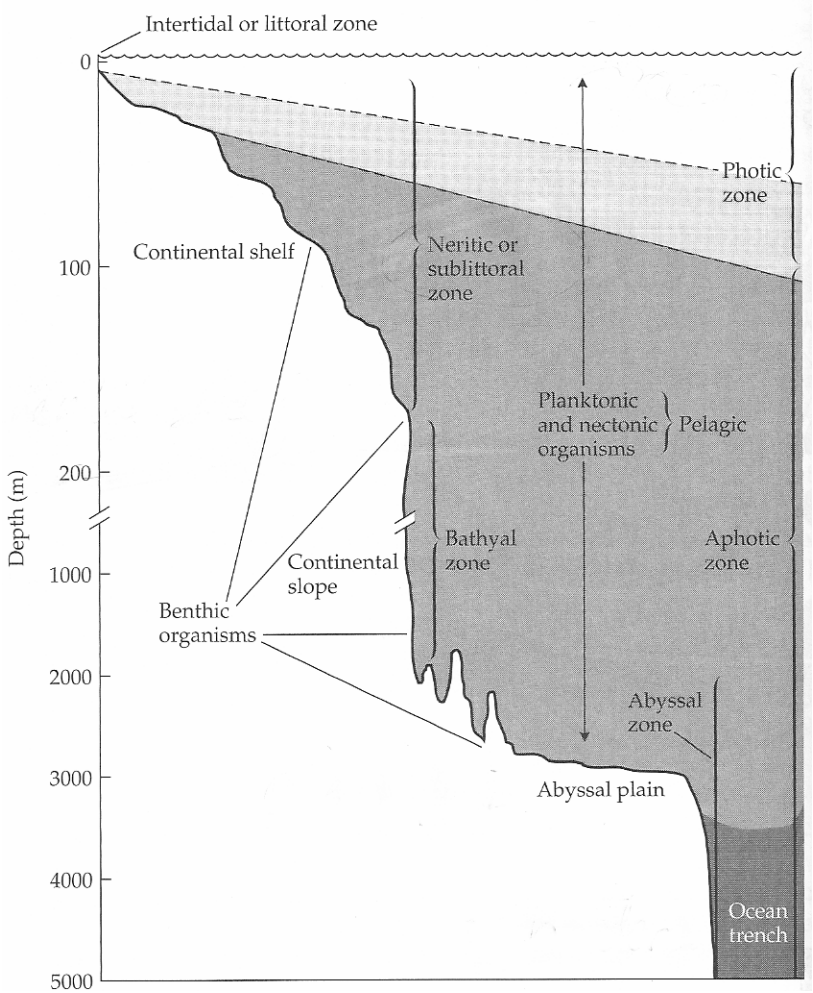

Figure 1. Zones of the world's oceans (Lomolino *et al.* 2006).

Homogeneity of deep-sea water is a result of the continuity of deep water throughout the world's oceans. Deep water is moved throughout the world's oceans on

what was termed by Broecker (1991) as the great ocean conveyor (Figure 2); the complete cycle takes approximately 1,000 years (Segar 1998). The flow of oceanic water is known as thermohaline circulation because it is controlled by temperature and salinity, which determine its density; the density of the water and the topology of the ocean floor determine where the water will move.

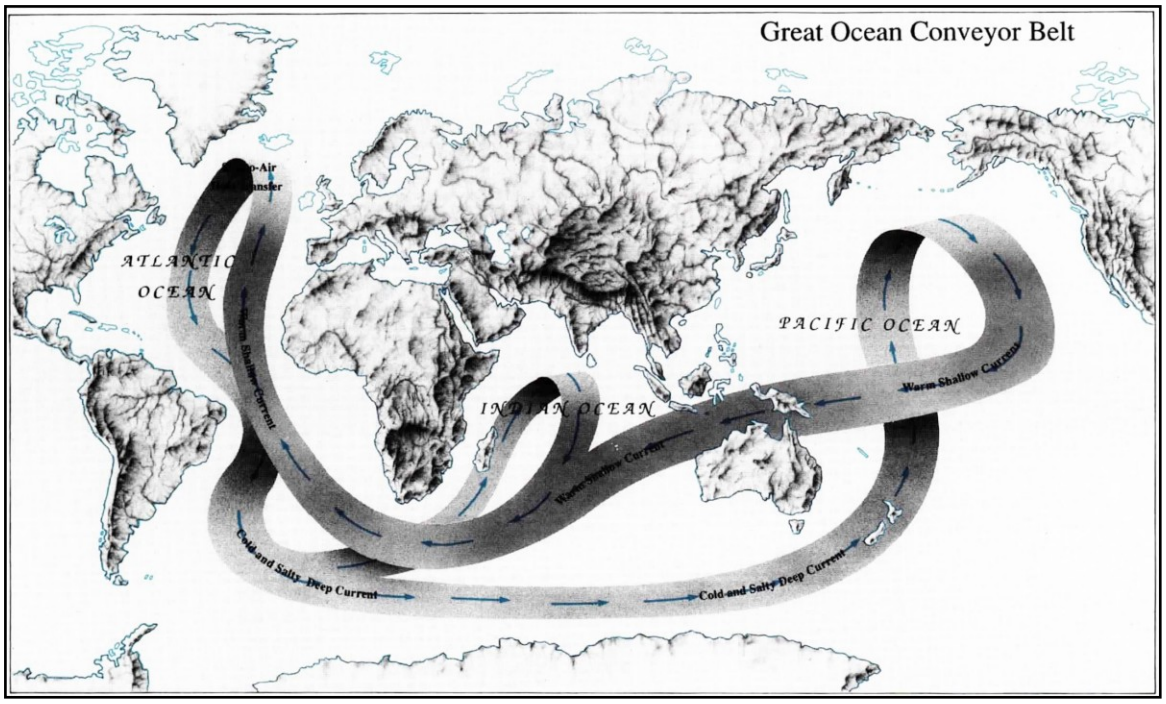

Figure 2. The great ocean conveyor belt from Broecker (1991).

As surface water cools or becomes more saline, it increases in density, and sinks. At extremely high latitudes, very cold temperatures cause seawater to freeze. As it does so, the water freezes, excluding the salt; this causes the water underlying the ice to increase in salinity (Segar 1998). In Antarctica, cold water (mostly from the Weddell and partially from the Ross seas) mixed with highly saline circumpolar water in the Southern Ocean (the Southern Ocean is defined as the seas south of the Antarctic Polar Front [Deacon 1982; Rodríguez *et al.* 2007]) sinks to produce Antarctic Bottom Water

(AABW). In the northern hemisphere, North Atlantic Deep Water (NADW) is produced through cooling in the Norwegian Sea (Gage and Tyler 1992). Dense water produced in the North Atlantic and the Southern oceans sinks to the deep sea, displacing the deep water that was there.

In the Atlantic Ocean, AABW flows northward and NADW flows southward. NADW, being slightly less dense than AABW, rides up where they meet; NADW becomes a source for Circumpolar Deep Water (CDW), which travels around Antarctica and supplies deep water to the other oceans. CDW also mixes with the cold waters of the Weddell and Ross Sea; together they produce AABW. The Indian Ocean is supplied by CDW and to a small degree by NADW. CDW is the sole source of deep water in the Pacific Ocean. The North Pacific Ocean does not contribute to the production of deep water because the dense water of the Arctic is trapped by the Aleutian Island chain, and large inputs of fresh water into the northeastern Pacific prevent surface waters from becoming dense and sinking.

Deep water rises to the surface and is warmed as it approaches steep continental slopes, such as in the northeastern Pacific, and will eventually be pushed to the poles as it is continually displaced (Figure 2); as CDW rises in the North Pacific, it becomes North Pacific Deep Water (NPDW) and is returned southward as it slowly rises. In the Pacific Ocean, CDW lies below 3,000 m (within the abyssal zone) and NPDW lies between 1,500 and 3,000 m (within the bathyal and abyssal zones); intermediate water lies above the deep water masses between approximately 400 and 1,500 m (within the bathyal zone) and Mode Water (MW) lies above intermediate water between 100 and 400 m (near the shelf break) (Swan *et al.* 2009).

Deep-sea anemone biogeography. Very little is known about the distribution of deep-sea anemones. However, Rodríguez *et al.* (2007) found that all 31 families in the Southern Ocean (a source of deep water) as well as 75% of the genera have representatives elsewhere in the world, but 75% of the species are endemic. These results are similar to Vinogradova's (1959) findings. I also found that all families, as well as 92% of the genera (of 14 genera, all except for *Paraphelliactis*), have representatives outside the Pacific Ocean, and that 71% of the species are endemic to the North Pacific.

From the 14 species of sea anemones I studied, I identified two new species (*Bolocera kensmithi* n. sp. and *Sicyonis careyi* n. sp.) that are known only from the northeastern Pacific Ocean, and one species (*Actinoscyphia groendyki* n. sp.) that is found in both the North Pacific and Southern Oceans. Of the remaining species, only one is cosmopolitan, *Actinauge verrillii* McMurrich, 1893, one has also been recorded in the Atlantic, *Monactis vestita* (Gravier, 1918), and one has also been recorded in the Southern Ocean, *Bathyphellia australis* Dunn, 1983. The rest are known only from the North Pacific; three species are known from both the northeastern and northwestern Pacific Ocean: *Liponema brevicorne* (McMurrich, 1893), *Metridium farcimen* (Brandt, 1835), and *Paractinostola faeculenta* (McMurrich, 1893). All others are endemic to the northeastern Pacific Ocean: *Corallimorphus denhartogi* Fautin, White, and Pearson, 2002*, Corallimorphus pilatus* Fautin, White, and Pearson, 2002*, Anthosactis nomados* White, Wakefield Pagels, and Fautin, 1999*, Paraphelliactis pabista* Dunn, 1982, and *Sagartiogeton californicus* (Carlgren, 1940). Populations of those species that live in the northeastern Pacific near the OMZ, especially within shallow and intermediate waters, may become threatened as the OMZ continues to strengthen and expand.

Materials and Methods

Specimens. I examined 934 lots containing 8,226 specimens of 14 species from five museums (see Appendices). I describe in detail species that were previously unknown, and one (*Sagartiogeton californicus*) for which the original description was brief and lacked information. Other previously known species are briefly discussed and their distributions given. I used the original descriptions and re-descriptions of morphologically similar species to prepare each differential diagnoses and dichotomous key. In the results section, species treatments of members of order Corallimorpharia are listed first; families are listed alphabetically within their respective order, as are genera within each family.

Specimens were collected by beam and otter trawls along the northeastern Pacific Ocean (from southern California to British Columbia) to 4,325 m depth. Most specimens were collected during studies conducted either off the coast of Oregon in the 1960s and 1970s (*e.g.* McCauley and Carey 1967; Carney and Carey 1982) by Andrew Carey of Oregon State University, or approximately 200 km off the coast of California at Station M (Smith *et al.* 1994) in the 1990s by Kenneth L. Smith Jr., then of Scripps Institution of Oceanography (now at the Monterey Bay Aquarium Research Institute, Moss Landing, California). Most of Carey's specimens are now held at SBMNH, and Smith's are held at KUBI.

I supplemented Carey's and Smith's material with specimens collected elsewhere in the northeastern Pacific Ocean including specimens held at KUBI and SBMNH, as well as at RBCM (most collected off British Columbia in the early 2000s) and CAS, and a syntype of *Actinauge verrillii* from USNM.

Histology. Histological sections were prepared by embedding specimens in Paraplast®, sectioning at 8-12 μm, and staining with hematoxylin and eosin (Humason 1967).

Cnidae. Undischarged cnidae were measured from squash preparations of tissue from tentacles, column, actinopharynx, acontia, and mesenterial filaments at 1,000x using a compound light microscope equipped with differential interference contrast (Nomarski) optics. Cnidae were not measured from the column of animals that were devoid of ectoderm, a state common in deep-sea anemones (Carlgren 1956; Fautin and Hessler 1989; Riemann-Zürneck1994; White *et al.* 1999).

In tables displaying nematocyst measurements, "N" represents the fraction of animals examined that contained a particular type of cnida, and "n" represents the total number of capsules measured. Letters refer to image of the corresponding cnida in the figure.

Images. Specimens were photographed using the macro-setting of a 3.3 megapixel Nikon Coolpix 995 digital camera. Images of cnidae were taken using a 3 megapixel SPOT idea USB digital camera attached to an Olympus compound light microscope. Depending on the magnification required to photograph histological sections, either the Nikon digital camera attached to an Olympus dissecting microscope or the SPOT digital camera attached to the Olympus compound light microscope was used.

Maps. Distribution maps were created using all available locality data from museum specimens and literature. Using ArcInfo, specimens with latitude, longitude, and depth

data are represented as circles on distribution maps. For specimens without latitude and longitude data, localities were estimated by georeferencing localities from the Hexacorallians of the World database (Fautin 2009). If a georeference was not available, the locality was determined by using the centroid for a known cruise, or by using NOAA nautical charts, taking into consideration the depth at which specimens were collected (if depth were available); estimated localities (for which latitude/longitude and/or depth were not available) are represented as triangles. New localities are represented by solid symbols; previously published localities are represented by open symbols with a dot in the center. All depths are given in meters and the average depth was used in the maps for those localities with depth ranges. Depths were estimated in the maps for specimens with no depth information by using the etopo2 ($2'^{2}$) bathymetry data set. For a list of all specimens and locality data, see the appendices.

Results

Dichotomous Key of Northeastern Pacific Sea Anemones

This list includes only the 14 species that were examined for this study.

1. Lack marginal sphincter muscle and siphonoglyphs. Each tentacle with acrosphere.....2

- Marginal sphincter muscle and siphonoglyphs present. Tentacles lack acrospheres.....3

2. Column cylindrical. Approximately 130 tentacles; marginal and discal tentacles occur in 4:1 ratio……...*Corallimorphus pilatus* (p. 21)

- Column discoidal. Approximately 72 tentacles; marginal and discal tentacles in 2:1 ratio……..…...…*Corallimorphus denhartogi* (p. 18)

3. Marginal sphincter muscle endodermal, tentacles deciduous….……..……...4

- Marginal sphincter muscle mesogleal, tentacles not deciduous…….……...…..5

4. Approximately 48 tentacles arrayed along margin; one tentacle per exocoel……..……...…....*Bolocera kensmithi* n. sp. (p. 23)

- To several hundred tentacles scattered all over oral disc; more than one tentacle per exocoel…….....……..*Liponema brevicorne* (p. 68)

5. Acontia absent. Mesenteries not divisible into macrocnemes and microcnemes..……..6

- Acontia present……9

6. Column mesoglea thick; animals long..……...7

- Column mesoglea thin; animal flat. Attaches to scaphopod shell.....*Anthosactis nomados* (p. 40)

7. More than six pairs of mesenteries complete; members of young mesentery pairs not equally developed. Tentacles cover at least half of oral disc…...……8

- Six pairs of mesenteries complete; members of young mesentery pairs equally developed. Tentacles restricted to margin, aborally thickened at base……..*Actinoscyphia groendyki* n. sp. (p. 31)

8. Column bumpy; typically tapers distally to proximally. To more than 200 tentacles. Mesenteries most numerous distally…….…….....*Paractinostola faeculenta* (p. 42)

- Column smooth; typically cylindrical. Approximately 80 tentacles. Mesenteries most numerous proximally…….…….....*Sicyonis careyi* n. sp. (p. 47)

9. Mesenteries not divisible into macrocnemes and microcnemes……10

- Mesenteries divisible into macrocnemes and microcnemes. Pedal disc attaches to manganese nodule..……..…….....…*Bathyphellia australis* (p. 57)

10. Oral disc not lobed. Column divisible into scapus and scapulus……..……...11

- Oral disc lobed. Column divisible into scapus and capitulum. Acontia with microbasic *b*-mastigophores and microbasic amastigophores.....*Metridium farcimen* (p. 71)

11. Acontia with only basitrichs. Cinclides absent……12

- Acontia with basitrichs and microbasic amastigophores. Cinclides present…….*Sagartiogeton californicus* (p. 74)

12. Scapus with tubercles. 90 to 150 tentacles, aborally thickened at base……...13

- Scapus lacking tubercles. Approximately 32 tentacles, not aborally thickened at base……..……..…*Monactis vestita* (p. 63)

13. Tubercles pointed; arrayed in longitudinal rows. Tentacles more numerous than number of mesenteries at mid-column.....*Paraphelliactis pabista* (p. 65)

- Tubercles flat; not arrayed in longitudinal rows. Same number of tentacles as mesenteries along column……...…….*Actinauge verrillii* (p. 60)

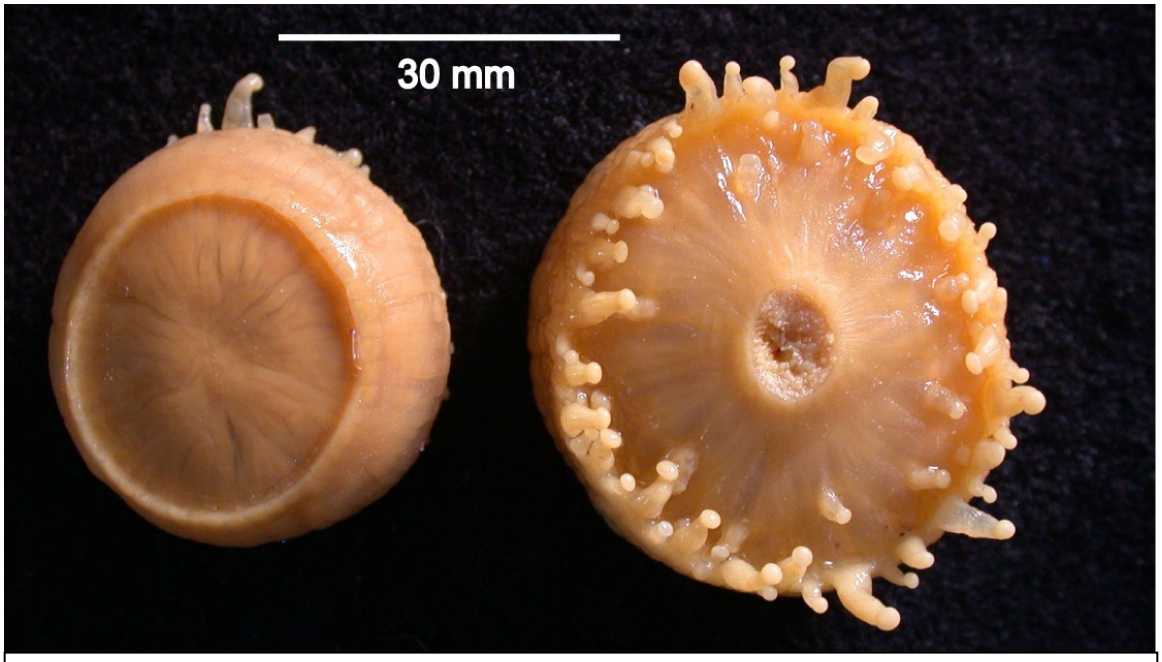

Figure 3. Specimens of *Corallimorphus denhartogi* (KUBI 001554).

Order Corallimorpharia

Family Corallimorphidae

***Corallimorphus denhartogi* Fautin, White, and Pearson, 2002**

Description. Column short and discoidal (Figure 3); oral disc to approximately 70 mm diameter; ectoderm sloughed off in nearly all specimens. Mouth small (less than 1/3 oral disc diameter), ovoid; lips around mouth indistinct. Tentacles short and capitate, acrospheres typically broken off. Marginal and discal tentacles in 2:1 ratio (~ 72 total). All discal tentacles short, approximately same size (2 mm long); marginal tentacle in three sizes (~12 large, 12 medium, 24 small), to 8 mm long. Limbus typically extends below slightly concave pedal disc. For a detailed description of *C. denhartogi,* see Fautin *et al.* (2002).

Cnidae. Spirocysts, holotrichs, basitrichs, microbasic *p*-mastiogophores, and microbasic *b*-mastigophores.

Discussion. *Corallimorphus denhartogi* was originally described from California to Oregon at depths of 2,550 to 4,300 m (Fautin *et al.* 2002). All specimens occur within the previously known range. *Corallimorphus denhartogi* lives in the NPDW and CDW of the northeastern Pacific Ocean (Figure 4).

Specimens Examined. See Appendix 4.

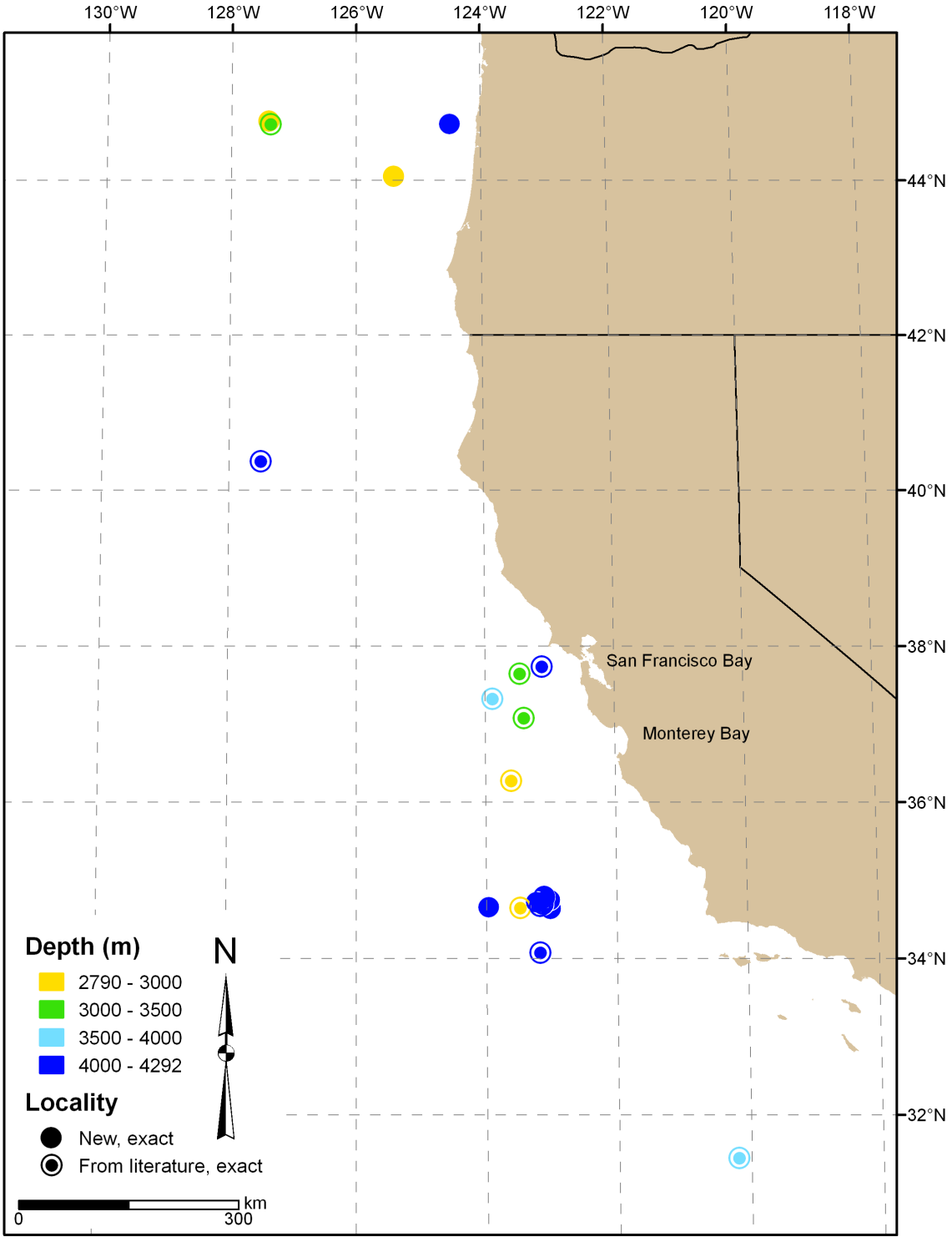

Figure 4. Distribution of *Corallimorphus denhartogi* from southern California to Oregon.

Corallimorphus pilatus

Fautin, White, and

Pearson, 2002

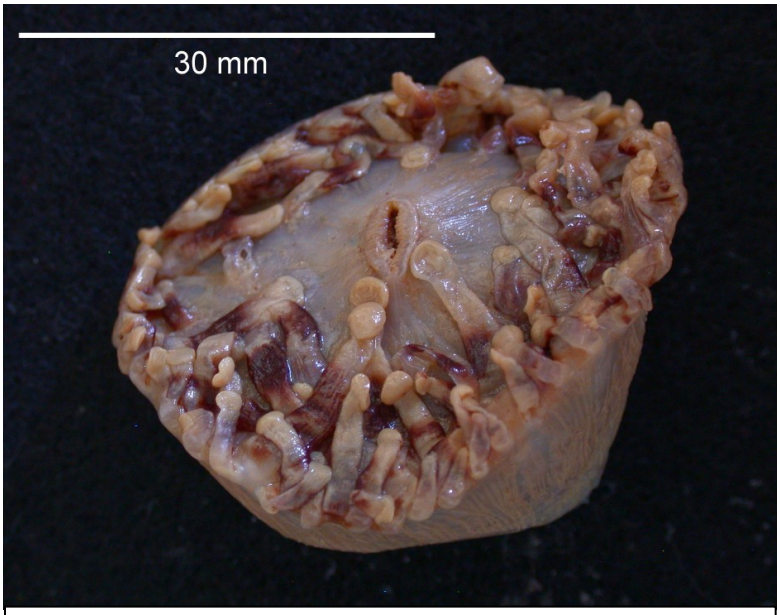

Figure 5. Specimen of *Corallimorphus pilatus* (KUBI 003256).

Description. Column cylindrical; oral and pedal discs approximately same diameter (to 35 mm), column slightly shorter than diameter of discs (to 20 mm). Pedal disc typically attached to stone or shell. Sparse tan ectoderm attached to column; brown ectoderm near base of tentacles. Oral disc with raised lips around slit mouth; with long, capitate tentacles (Figure 5). Marginal tentacles shorter than discal tentacles (~15 mm), in 4:1 ratio (marginal to discal; ~ 130 total). For a detailed description of *C. pilatus* see Fautin *et al.* (2002).

Cnidae. Spirocysts, holotrichs, basitrichs, microbasic *p*-mastiogophores, and microbasic *b*-mastigophores.

Discussion. *Corallimorphus pilatus* was originally described from California to British Columbia at depths of 198 to 900 m (Fautin *et al.* 2002). Additional specimens I have examined extend the range north to include south coastal Alaska and down to 2,026 m

[1,108 fm]. *Corallimorphus pilatus* lives in MW and intermediate water of the northeastern Pacific Ocean (Figure 6).

Specimens Examined. See Appendix 5.

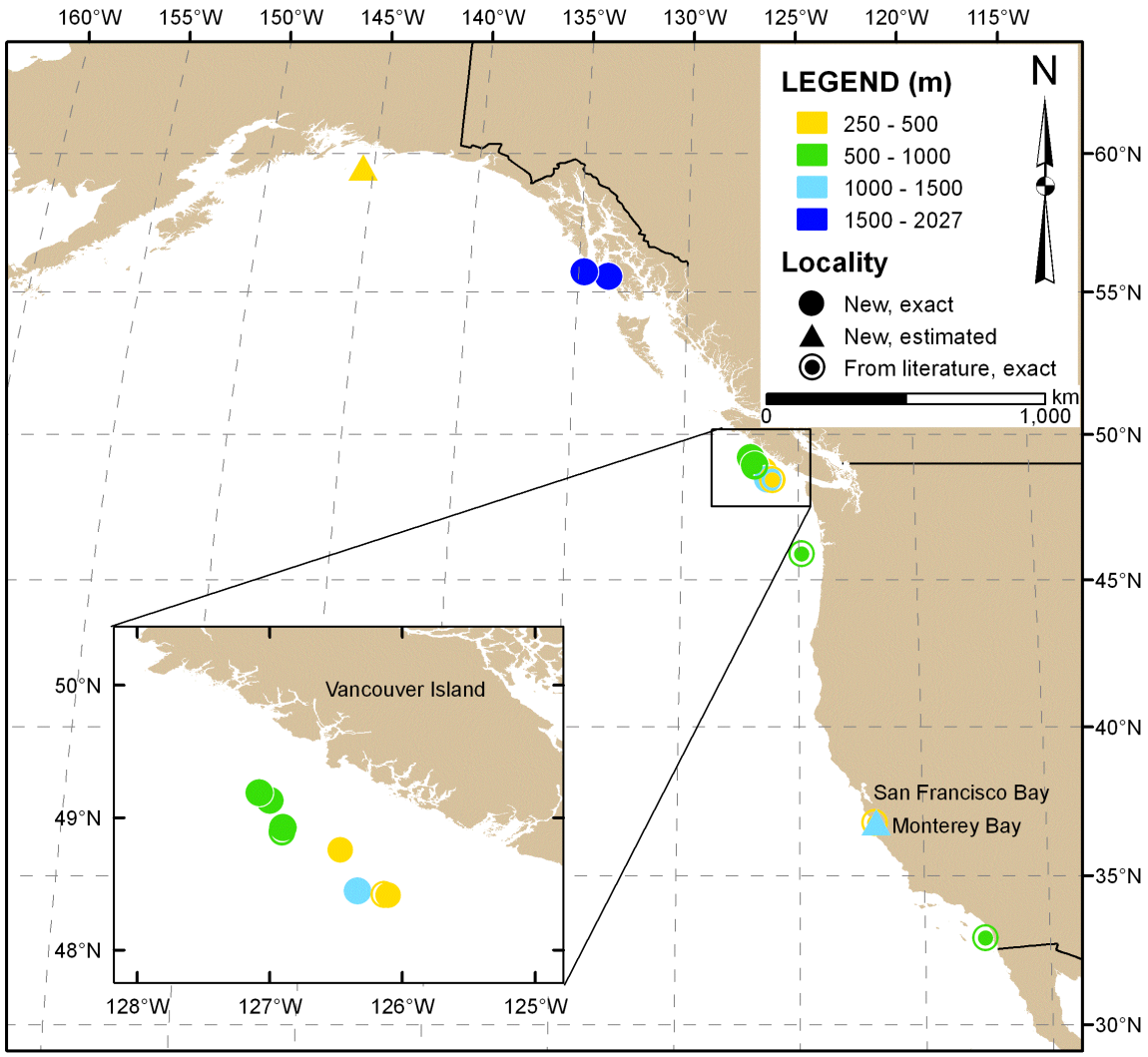

Figure 6. Distribution of *Corallimorphus pilatus* from California to the Gulf of Alaska.

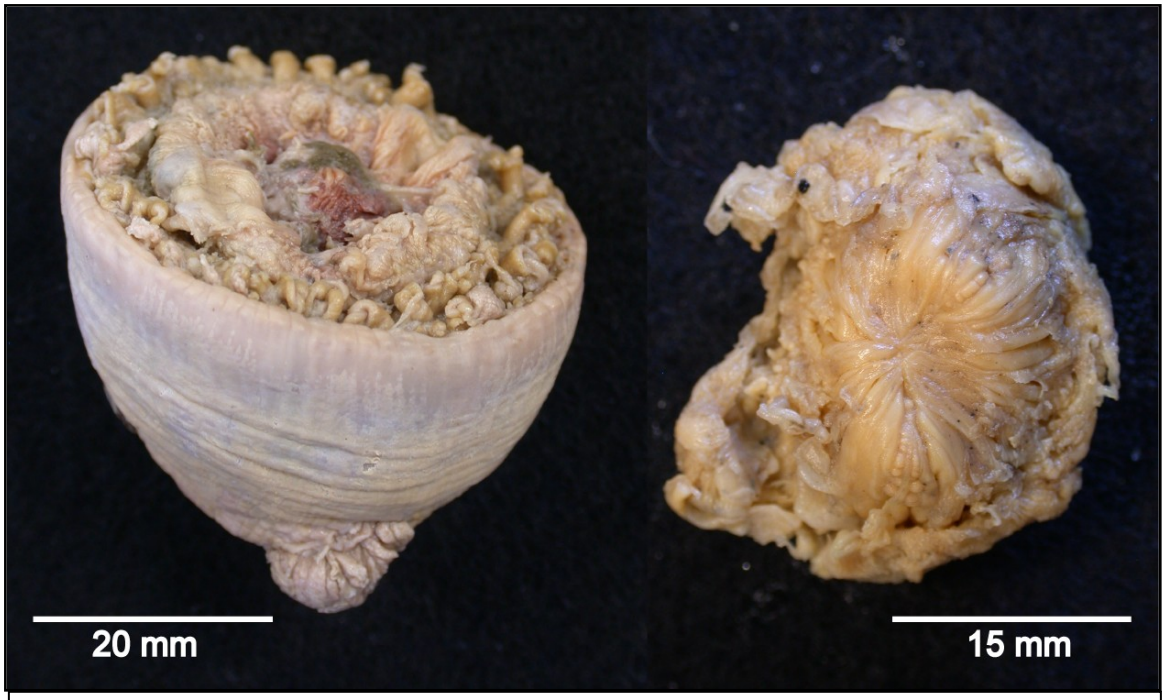

Figure 7. Specimens of *Bolocera kensmithi* n. sp. Specimen lacking tentacles on left (KUBI 003252). Specimen lacking tentacles and turned inside-out on right (KUBI 001518).

Order Actiniaria

Family Actiniidae

Species *Bolocera kensmithi* n. sp.

Body Form and Size. Column tan or pink, smooth, ectoderm typically slightly wrinkled. Column stiff but not thick (~ 0.5 mm); mesenterial insertions typically visible along entire length, most evident at limbus and margin. In some preserved specimens mesenteries protrude from proximal end of column or pedal disc (Figure 7).

Most animals contracted so margin partially covers insertion of tentacles. Column short (10-31 mm long), in most animals tapers from oral disc (8-41 mm diameter) to pedal disc (3-22 mm diameter); one specimen inside-out so mesenteries were exposed (Figure 7).

Tentacles deciduous (characteristic of genus): sphincter muscle at base of each tentacle. All specimens devoid of tentacles.

Pedal Disc. Pedal disc tan to pink; circular, slightly concave, may be wrinkled or smooth. Approximately half diameter of oral disc.

Oral Disc and Tentacles. Oral disc tan to reddish-purple; smooth in poorly preserved specimens, radially furrowed along mesenterial insertions in well preserved specimens. In most specimens, oral disc torn, and mesenteries protrude through mouth. Mouth large (~ 2/3 diameter of oral disc, opening to 18 mm); radially furrowed, lips raised and very prominent when mouth not torn (to 5 mm wide and long). Two prominent, symmetrical, off-white siphonoglyphs apparent in specimens with intact oral disc.

Number and arrangement of tentacles inferred by presence of pores (to ~ 2 mm diameter) on oral disc; small ridge typically surrounds each pore. To 72 pores, approximately 48 in most specimens, arrayed in three or four cycles; those of inner cycles communicate with endocoels, those of outermost cycle communicate with exocoels.

Internal Anatomy. Actinopharynx tan to deep purple, longitudinally furrowed; protruded in most specimens, nearly same length as column. Two long symmetrical siphonoglyphs attach to two pairs of directive mesenteries.

Mesenteries thick and muscular, hexamerously arrayed in three complete cycles; typically more numerous at limbus than at margin (*e.g.* 56 vs 48). Rarely members of fourth cycle present; one pair develop beside mesenteries of the third cycle nearest

mesenteries of the second cycle (*e.g.* 11**44**33442244334**4**11, bolded 4s represent position of quaternary mesenteries that are absent in most specimens examined). All mesenteries with filaments complete, although youngest mesenteries reach actinopharynx only at distal end. Oral stomata large, marginal stomata small. Directives and some members of youngest cycle sterile; all other mesenteries fertile. Sexes separate; ova to ~1.5 mm diameter.

Retractor muscles strong and diffuse (Figure 8); in some specimens may be lobed. Parietobasilar muscles on short detached pennons, or no pennon.

Diffuse endodermal marginal sphincter muscle poorly developed; lamellae short to moderately long (Figure 9). Tentacular sphincter muscle endodermal.

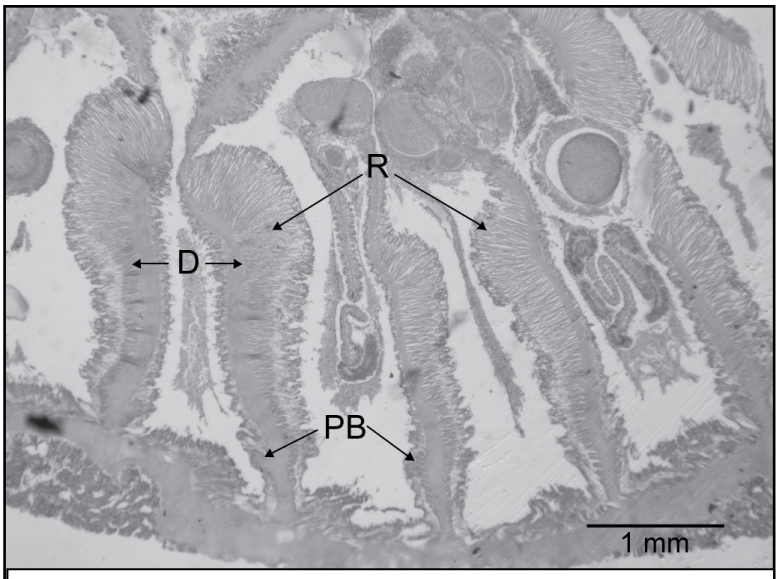

Figure 8. Cross section of *Bolocera kensmithi* n. sp. with directive mesenteries (D), diffuse retractors muscles (R), and parietobasilar muscles (PB).

Cnidae. Basitrichs and microbasic *p*-mastigophores. Sizes and distribution of cnidae shown in Table 1, illustrated in Figure 10. No tentacle cnidae were measured.

Etymology. Named in honor of Kenneth L. Smith Jr., who collected specimens of this species, as well as many other deep-sea anemones, from Station M off the coast of California.

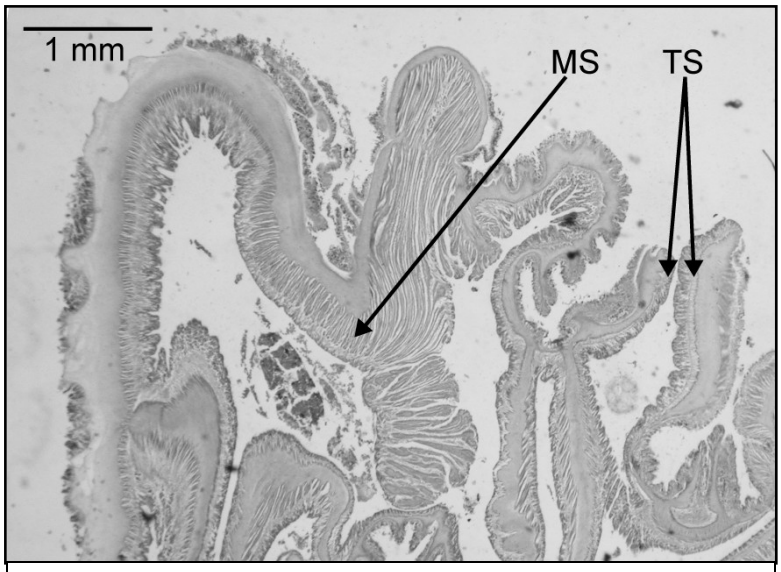

Figure 9. Longitudinal section of *Bolocera kensmithi* n. sp. with endodermal marginal sphincter (MS) and endodermal tentacle sphincter muscle (TS).

Discussion. *Bolocera kensmithi* n. sp. lives in the NPDW and CDW of the northeastern Pacific Ocean, and has been collected in trawls from 1,804-1,827 m to 4,100 m (Figure 11). The only other species of *Bolocera* known from the northeastern Pacific is *B. pannosa,* which is easily differentiated from *B. kensmithi* n. sp.; *B. pannosa* has a large, convex oral disc covered by approximately 400 tentacles, and the disc covers the low column.

Specimens Examined. See Appendix 6.

Differential Diagnosis. *Bolocera kensmithi* n. sp. can be distinguished from its congeners by its combination of: concave pedal disc; column that tapers from the widest part distally to the narrowest part proximally; approximately 48 tentacles arrayed in four cycles; 24 pairs of mesenteries arrayed in three cycles (occasionally a few additional pairs of a forth cycle present); infertile directive mesenteries; marginal stomata; size and distribution of cnidae.

Dichotomous Key of *Bolocera

1. Low column folded over so margin almost touches limbus……..…...…2

- Column not short, either cylindrical or wider at distal than at proximal end, margin not near limbus…….……....3

2. Approximately 400 flaccid slender tentacles to 37 mm long arrayed in seven cycles. Pedal disc oval (70 x 25 mm diameter in average specimen) and thin; mesenterial insertions visible. Northeastern Pacific Ocean……..… *B. pannosa*

- Approximately 150 blunt digitiform tentacles to 20 mm long scattered over oral disc. To five cycles of mesenteries; oral and marginal stomata present. Pedal disc circular, slightly larger diameter than proximal end of column. Two size classes of basitrichs in actinopharynx. Southern Ocean…….…… ……..… *B. paucicornis*

3. Marginal sphincter well developed……..4

- Marginal sphincter poorly developed….……...…….……...5

4. Column approximately twice as long as diameter of oral and pedal disc in preserved specimens; tentacles arrayed in four cycles. Off East Africa……*B. africana*

- Column thin, same length as diameter of oral disc in preservation. Approximately 200 long, conical, and longitudinally furrowed tentacles arrayed in five or six cycles. Northern Atlantic Ocean……..……..… *B. tuediae*

5. All mesenteries fertile except for directives and some of youngest cycle…...……...…6

- Mesenteries of first cycle, and some of second cycle sterile; 96 pairs of mesenteries total, 48 pairs complete. Approximately 180 tentacles. Off East Africa……...… *B. somaliensis*

6. Mesenteries lack oral and marginal stomata. To five cycles of thin mesenteries equally developed along column; parietobasilar muscles with large detached pennons. Tentacles (to ~100) arrayed in up to seven cycles. Basitrichs of mesenterial filaments to 64 μm long, one size class of basitrichs in column. South of 30°S.....*B. kerguelensis*

- Mesenteries possess oral and marginal stomata. 24 pairs of thick and muscular mesenteries arrayed in three cycles (rarely a few pairs of a forth cycle present), develop from proximal end; parietobasilar muscles with small detached pennons or without pennons. Approximately 48 tentacle pores (correspond to number of tentacles in life) arrayed in four cycles near margin. Pedal disc circular. Basitrichs of mesenterial filaments to 73 μm long; two size classes of basitrichs in column. Northeastern Pacific Ocean……....*B. kensmithi* n. sp.

* *Bolocera maxima* was described from off the coast of Greenland by Carlgren (1921) solely from tentacles, and was distinguished by its nematocysts. Because no comparable data are available for *B. kensmithi* n. sp., *B. maxima* has been omitted from the following key.

Tissue and Cnida Type	Length x Width (µm)	n	N
Actinopharynx			
Basitrichs (a)	(49.0) 54.1-75.7 x 4.0-5.1	36	5/5
Microbasic *p*-mastigophores* (b)	25.2-31.4 x 4.6-5.6 (6.0)	13	3/5
Mesenterial Filaments			
Basitrichs* (c)	21.2-28.7 (35.4) x 2.6-3.3	38	6/6
Basitrichs (d)	(57.1) 59.1-74.1 x 3.9-5.2	49	6/6
Microbasic *p*-mastigophores* (e)	(25.4) 26.9-36.2 (37.7) x 4.0-5.4 (5.9)	48	6/6
Column			
Basitrichs (f)	(18.0) 19.8-26.9 (29.0) x 2.3-3.2	30	5/5
Basitrichs (g)	36.1-50.8 (53.1) x 3.5-4.9	41	5/5

Table 1. Cnidae size and distribution of *Bolocera kensmithi* n. sp. All specimens lacked tentacles.
* Sparse.

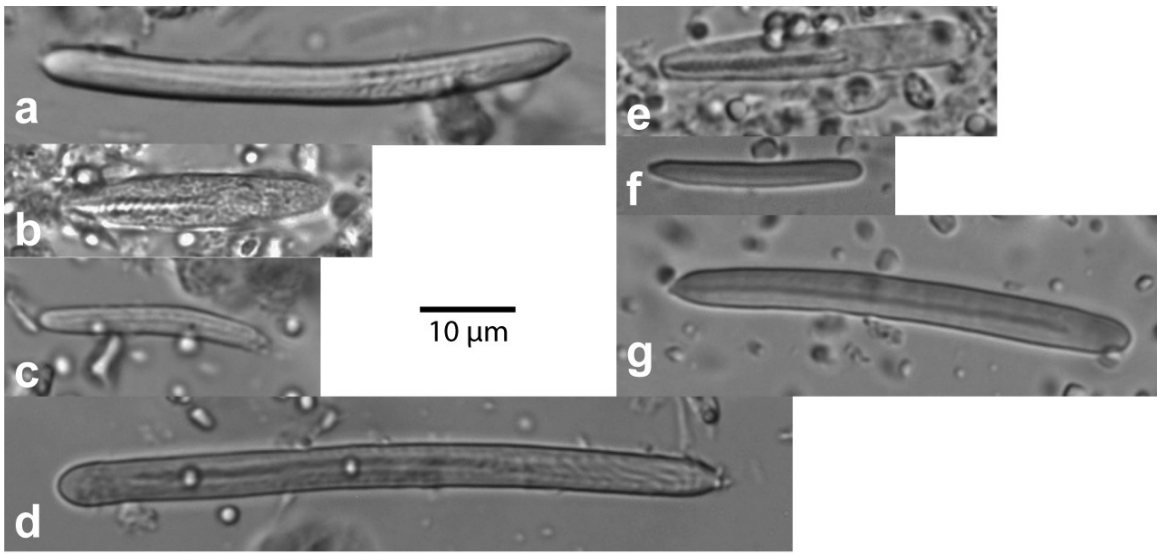

Figure 10. Cnidae of *Bolocera kensmithi* n. sp. Correspond to letters in Table 1.

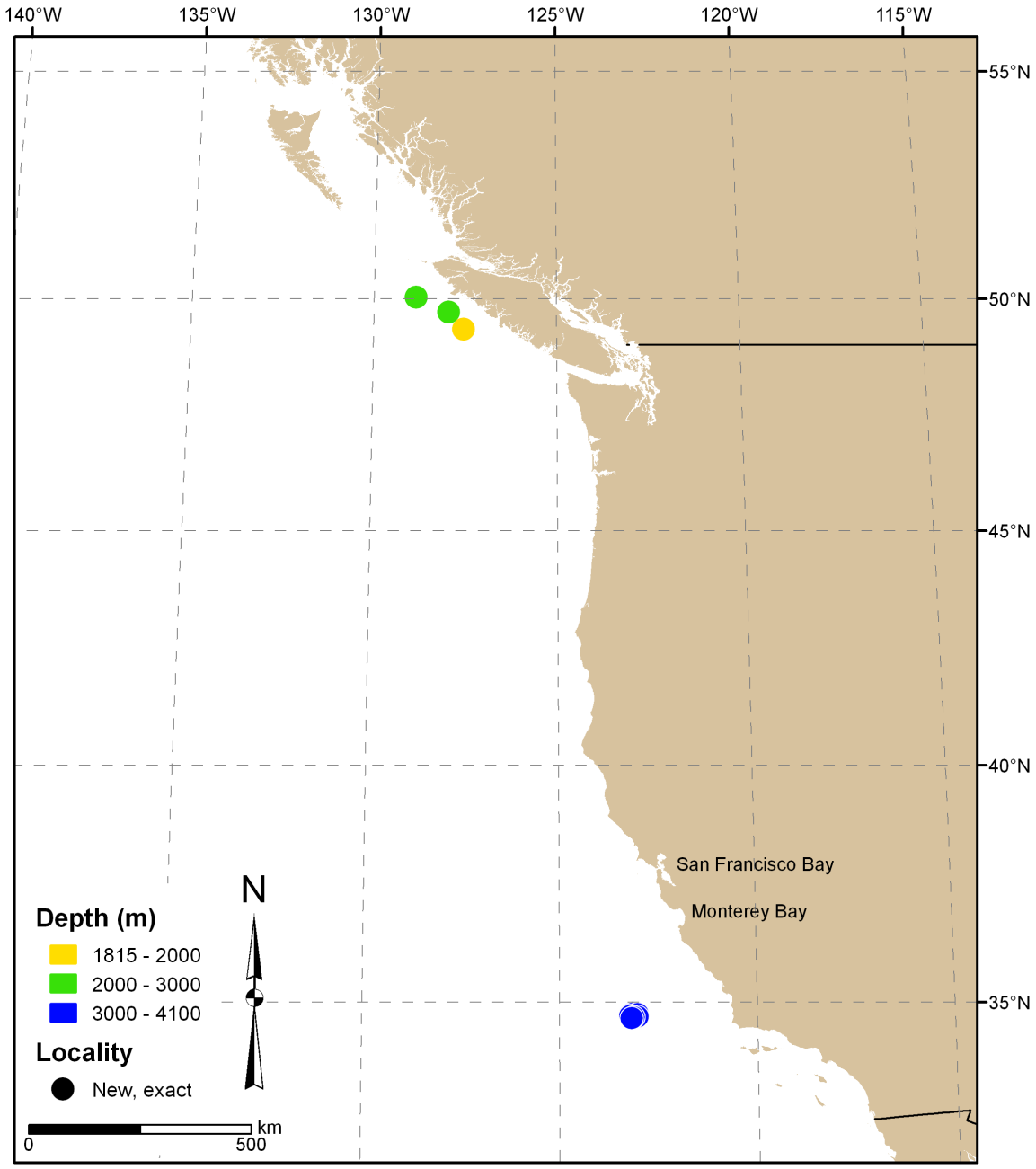

Figure 11. Distribution of *Bolocera kensmithi* n. sp. from California to British Columbia.

Family Actinoscyphiidae

***Actinoscyphia groendyki* n. sp.**

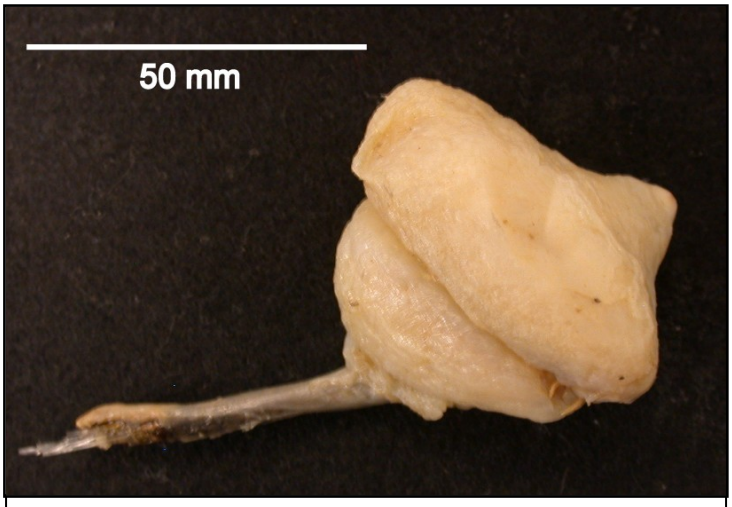

Figure 12. Specimen of *Actinoscyphia groendyki* n. sp. attached to sponge spicules (SBMNH 522590).

Body Form and Size. Exposed mesoglea of specimens light grey to tan; some with dingy grey ectoderm sloughing off. Mesoglea thick throughout column, to 8 mm at proximal end of specimen 33 mm long. Column smooth and stiff; tapers from widest part distally to narrowest part proximally. Margin contracted so column covers most tentacles. Oral disc in nearly all specimens examined folded in half perpendicular to long axis, giving animals Venus flytrap posture (Figure 12). Pedal disc elongate; long axis in same direction as long axis of oral disc.

Column 9-42 mm long; long axis of pedal disc, approximately same length as long axis of oral disc, typically longer than column.

Pedal Disc. Tan or light brown; most specimens with metallic brown chitinous material, inferred to be secreted by animal, closely associated with disc. Most elongate, from 4 to 134 mm; in large specimens pedal disc wrapped around or appear to have been wrapped around cylindrical object such as worm tube or group of sponge spicules. In small specimens (~10 mm column length) pedal disc small, concave, holds bolus of mud.

Oral Disc and Tentacles. Disc tan or salmon, oval/bilobate, radially furrowed along mesenterial insertion. Margin of two sides of disc fold toward center of animal, hide tentacles, and margin on opposing sides meet.

Mouth circular, approximately 1/4 oral disc diameter; with raised lips. Slightly darker than oral disc, or deep purple; tan or light brown radial stripe typically present at oral end of each siphonoglyph.

Tentacles slightly lighter in color than oral disc, smooth; tapered (1-4 mm at widest part of base to 0.1-1 mm at tip), 1-12 mm long, all with aboral mesogleal thickenings. Most specimens with 120-149 tentacles (one small specimen possessed only 90) arrayed in two cycles near margin; exocoelic tentacles short and outermost, endocoelic tentacles long and innermost.

Internal Anatomy. Actinopharynx deep purple, very long, longitudinally sulcate. Two symmetrical siphonoglyphs attached to two pairs of directive mesenteries; directive plane perpendicular to long axis of oral and pedal discs.

Mesenteries thin, typically arrayed in five cycles (specimens with column ~10 mm long possess only four cycles), all with filaments; those of only first cycle complete, stomata absent. Mesenteries of first cycle sterile, and those of second cycle rarely gametogenic; all younger mesenteries may be gametogenic. Mesenteries of youngest cycle regularly arrayed, but all pairs of same cycle do not develop simultaneously; rather than both flanking pairs of youngest cycle arising beside the preceding cycle, one pair of mesenteries develops later so it is typically absent. First pair to develop occurs on side nearer older pair of mesenteries (*e.g.* 11554**55**33**55**445522, bolded 5s represent where

late-developing pairs will presumably appear, although absent in specimens examined) (Figure 13a). Pattern is also true for development of forth cycle mesenteries; in one specimen both pairs flanked third cycle in some places, and only one pair had developed in others. Retractor muscles very weak and short; parietobasilar muscles weak.

Mesogleal marginal sphincter muscle weak, moderately long (to approximately 1/3 column length), with many alveoli, slightly striated transversely (Figure 13b). Situated in middle of mesoglea distally where broadest, occupies approximately half mesoglea width; tapers and approaches endoderm proximally. Alveoli pigmented, giving sphincter tan color. Distal alveoli small and may be spaced apart or clumped; proximal alveoli larger.

Longitudinal muscles of tentacles mostly ectodermal with little mesogleal involvement, circular muscles endodermal (Figure 13c).

Cnidae. Spirocysts, holotrichs, basitrichs, and microbasic *p*-mastigophores. Sizes and distribution of cnidae shown in Table 2, illustrated in Figure 14.

Etymology. Named in honor of my late grandfather, James Groendyk, for encouraging me to work hard and never stop learning.

Discussion. Fautin (1984) identified 18 specimens of *Actinoscyphia* collected from the Southern Ocean as *Actinoscyphia plebeia* (McMurrich, 1893). The specimens I examined from the northeastern Pacific accurately matched her description except that the microbasic *p*-mastigophores of the actinopharynx and large basitrichs of the mesenterial

filaments were smaller in the specimens I examined. However, there were some differences between those specimens determined by Fautin (1984) to be *A. plebeia* and the original description of the species by McMurrich (1893).

I examined both the holotype of *A. plebeia* (USNM 17789) and some of the Southern Ocean specimens examined by Fautin (1984); I have determined that the northeastern Pacific specimens, as well as the specimens described by Fautin (1984) constitute a single species that is distinct from *A. plebeia* most notably because of the shape of the sphincter muscle, thickness of the mesoglea, and cnidae (Tables 2 and 3). I measured smaller microbasic *p*-mastigophores of the actinopharynx and basitrichs of the mesenterial filaments in the specimens that Fautin (1984) examined, further supporting my decision. *Actinoscyphia groendyki* n. sp. occurs in both the Southern and Pacific oceans and has been collected in intermediate water, NPDW, and CDW from depths of at least 636 to 3,819 m (Figure 15).

I also examined the holotype of *A. saginata* (USNM 23836). All previously published nematocyst data on *A. saginata* indicate that the species has only one size class of basitrichs (small basitrichs). I found 10 basitrichs of ~35 x 4 μm in the mesenterial filaments. The basitrichs are approximately the same size as the microbasic *p*-mastigophores (~30-35 x 4 μm); it is likely that the basitrichs were misidentified as microbasic *p*-mastigophores in previous descriptions, or are found along only certain parts of the filaments.

Specimens Examined. See Appendix 7.

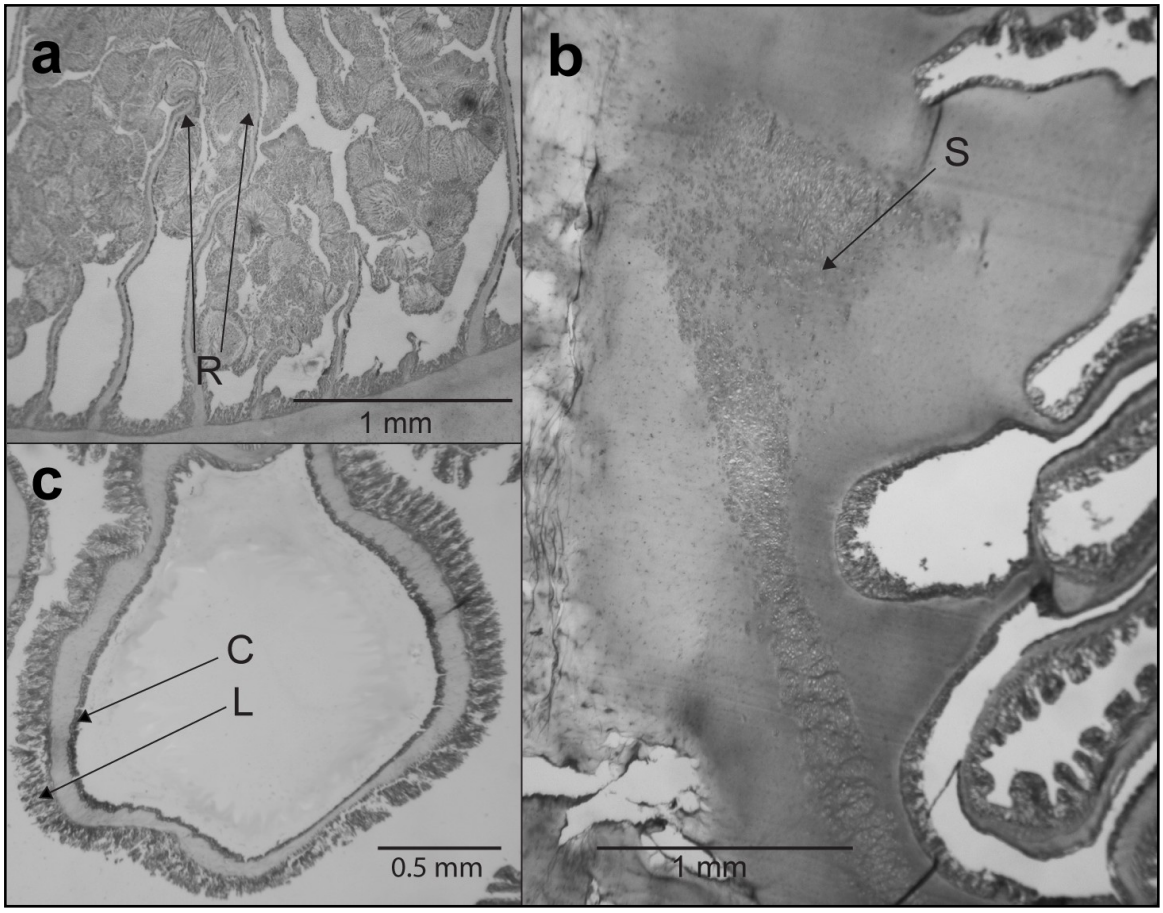

Figure 13. *Actinoscyphia groendyki* n. sp. a. Mesenteries with diffuse retractor muscles (R); b. Mesogleal marginal sphincter muscle (S); c. Cross section of tentacle with endodermal circular musculature (C) and ectodermal longitudinal musculature with little mesogleal involvement (L).

Tissue and Cnida Type	Length x Width (µm)	n	N
Tentacles			
Gracile spirocysts (a)	21.5-42.5 (46.3) x 3.2-5.2 (5.6)	45	4/4
Robust spirocysts (b)	25.6-64.4 x 4.2-11.3 (12.2)	51	4/4
Basitrichs (c)	12.0-15.8 (20.6) x 2.0-3.0	35	4/4
Basitrichs (d)	19.8-29.3 (31.1) x (3.2) 3.8-4.9	52	4/4
Holotrichs (e)	28.8-46.3 x 4.2-6.2	36	4/4
Actinopharynx			
Basitrichs (f)	23.9-33.6 (35.2) x 3.4-5.0 (5.4)	71	4/4
Microbasic *p*-mastigophores (g)	(19.9) 21.9-30.0 x 3.7-5.2 (5.5)	37	3/4
Mesenterial Filaments			
Basitrichs (h)	14.3-17.9 x 2.3-3.2	24	3/4
Basitrichs (i)	21.1-28.9 x 3.1-5.0	55	4/4
Microbasic *p*-mastigophores (j)	(18.2) 20.6-30.9 x 3.2-4.9 (5.3)	46	4/4

Table 2. Cnida size and distribution of *Actinoscyphia groendyki* n. sp.

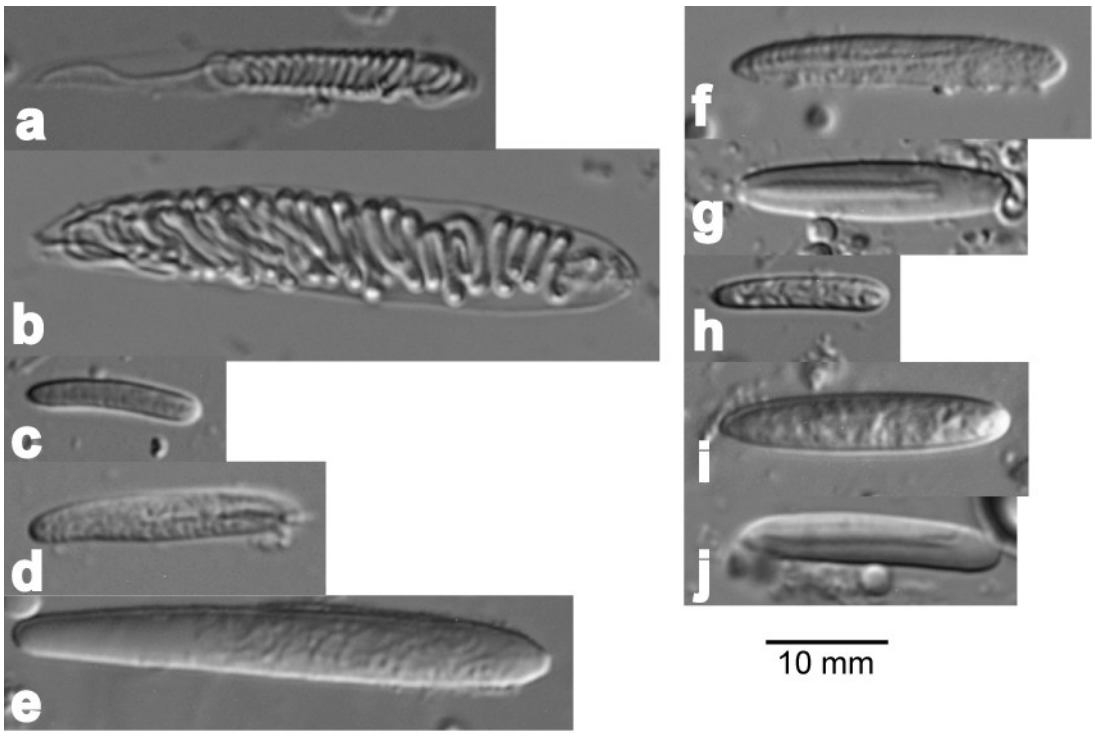

Figure 14. Cnidae of *Actinoscyphia groendyki* n. sp. Correspond to letters in Table 2.

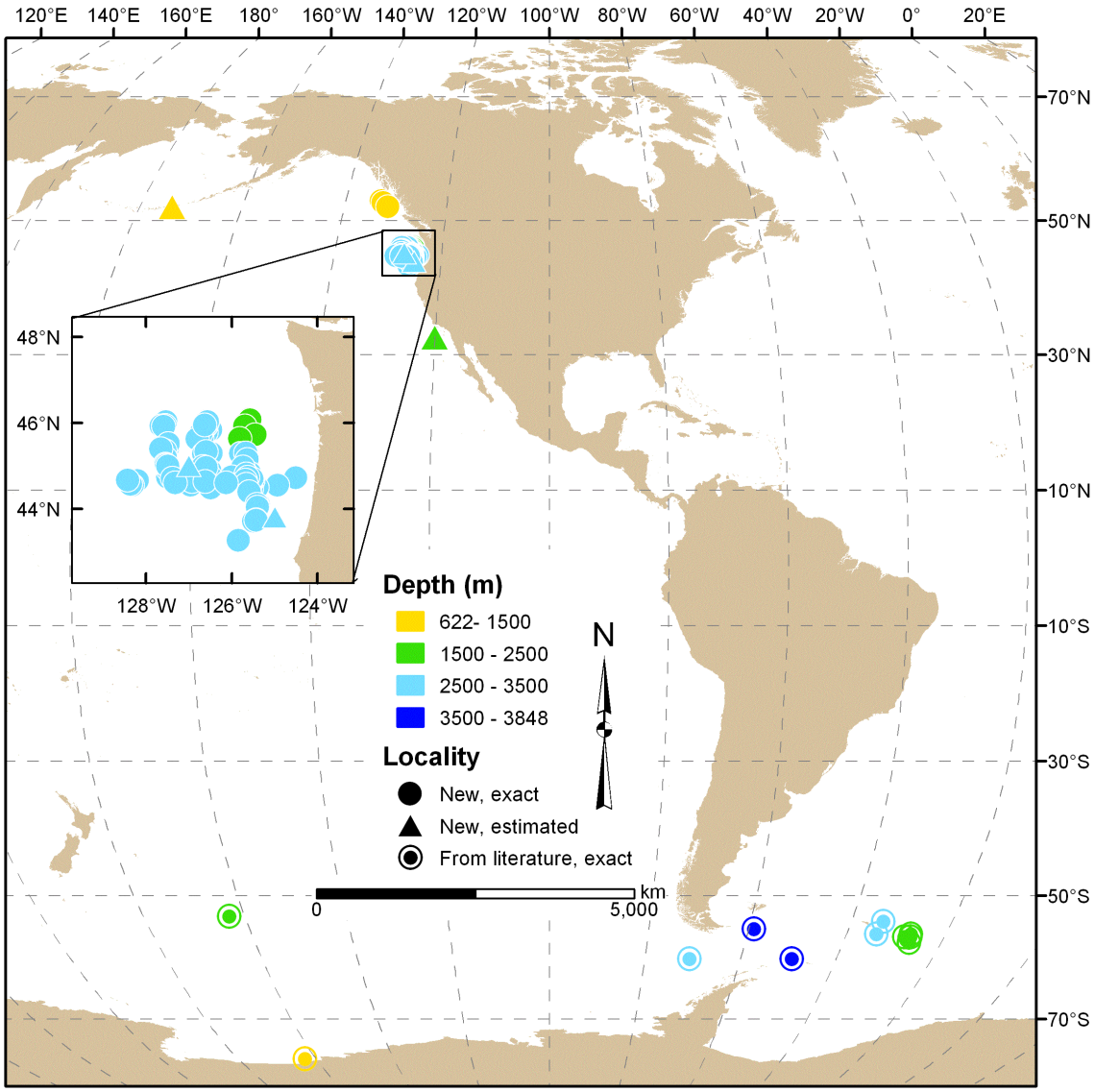

Figure 15. Distribution of *Actinoscypia groendyki* n. sp. from the Southern and northeastern Pacific Ocean.

Tissue and Cnida Type	Length x Width (µm)	n
Tentacles		
Spirocysts	(31.2) 39.3-51.1 x 6.2-8.2	11
Spirocysts	23.9-48.9 x 3.4-5.7 (6.8)	10
Basitrichs	11.9-14.4 x 1.9-2.3	10
Basitrichs	21.2-29.8 x 3.4-4.1	11
Actinopharynx		
Basitrichs	26.4-32.2 x 3.0-3.9	10
Mesenterial Filaments		
Basitrichs	11.4-15.3 x 2.1-2.8	10
Basitrichs	25.4-30.4 x 3.0-3.4 (3.9)	10

Table 3. Cnida size and distribution of holotype of *Actinoscyphia plebeia* (USNM 17789). Microbasic *p*-mastigophores are sparse in the actinopharynx of another species of *Actinoscyphia* (*A. groendyki* n. sp.); therefore, it is possible that I missed them, because only one specimen was examined.

Differential Diagnosis. *Actinoscyphia groendyki* n. sp. can be distinguished from its congeners by its combination of: elongate pedal disc; bilobate oral disc; to approximately 150 tentacles that are aborally thickened; five cycles of mesenteries (to 144 mesenteries at limbus), of which six pairs are complete and the first and typically the second cycle are sterile; absence of stomata; moderately long mesogleal marginal sphincter with pigmented alveoli; size and distribution of cnidae.

Dichotomous Key of *Actinoscyphia*

1. Six pairs of complete mesenteries……2

- More than six pairs of mesenteries complete, more than 50 pairs of mesenteries total. Edges of oral disc undulate or folded against one another, pedal disc much smaller

than oral disc; attached to dead branches of *Lophelia*. North Atlantic Ocean…….. *A. verrilli*

2. Alveoli of marginal sphincter muscle pigmented……3

-Alveoli of marginal sphincter muscle lack pigmentation; oral disc slightly biolobate. Tentacles very long and thin (to ~50 mm length) with small aboral basal thickenings. To five cycles of mesenteries. North Atlantic Ocean..... *A. saginata*

3. Tentacles aborally thickened at base……..4

- Tentacles lacking aboral thickenings, short and slender, to 275 total; tentacles, oral disc, actinopharynx, and all endoderm except that of filaments dark red/purple. To seven cycles of mesenteries, oral stomata present. Pedal disc small and concave, holds dirt and mucus. North Atlantic Ocean……...…….……...…*A. aurelia*

4. Mesogleal marginal sphincter muscle distinctly transversely striated; mesoglea thinnest mid-column (~ 1 mm thick). Oral disc flat and circular, may fold on itself; to ~250 tentacles. To six cycles of mesenteries, oral stomata present. Holotrichs of tentacles and microbasic *p*-mastigophores of actinopharynx and filaments absent (Table 3). Southeastern Pacific Ocean…….……..……..…*A. plebeia*

- Mesogleal marginal sphincter muscle with small alveoli, may be slightly transversely striated; mesoglea thick through column, to ~ 8 mm. Oral disc bilobate (has long axis and short axis) and often folded on itself; to ~150 tentacles. To five cycles of mesenteries, lack stomata. Holotrichs of tentacles and microbasic *p*-mastigophores of actinopharynx and filaments present. Southern and northeastern Pacific Ocean.……...*A. groendyki* n. sp.

Figure 16. Specimen of *Anthosactis nomados* attached to shell of *Fissidentalium actiniophorum* (KUBI 001559).

Family Actinostolidae

***Anthosactis nomados* White, Wakefield Pagels, and Fautin, 1999**

Description. Body light tan to white, very flat; to 65 mm diameter. Individuals typically attached to shells of scaphopod *Fissidentalium actinophorum* (Figure 16). Animals not attached to shells show evidence of once having been attached to shells. Margin contracted so oral disc not visible. To 48 tentacles; taper to approximately 5 mm. Three cycles of mesenteries; lack acontia, first two complete. Much of internal anatomy of *A. nomados* not known because flattened body form makes it difficult to examine. For a detailed description of *A. nomados,* see White *et al.* (1999).

Cnidae. Spirocysts, basitrichs, microbasic *p*-mastigophores, and microbasic *b*-mastigophores.

Discussion. *Anthosactis nomados* was originally described from the northeastern Pacific off California and Oregon from 3,700 to 4,100 m (White *et al.* 1999). Additional specimens have been collected off California and Oregon from 530 to 4,325 m.

Anthosactis nomados lives in the in intermediate water, NPDW, and CDW of the northeastern Pacific (Figure 17).

Specimens Examined. See Appendix 8.

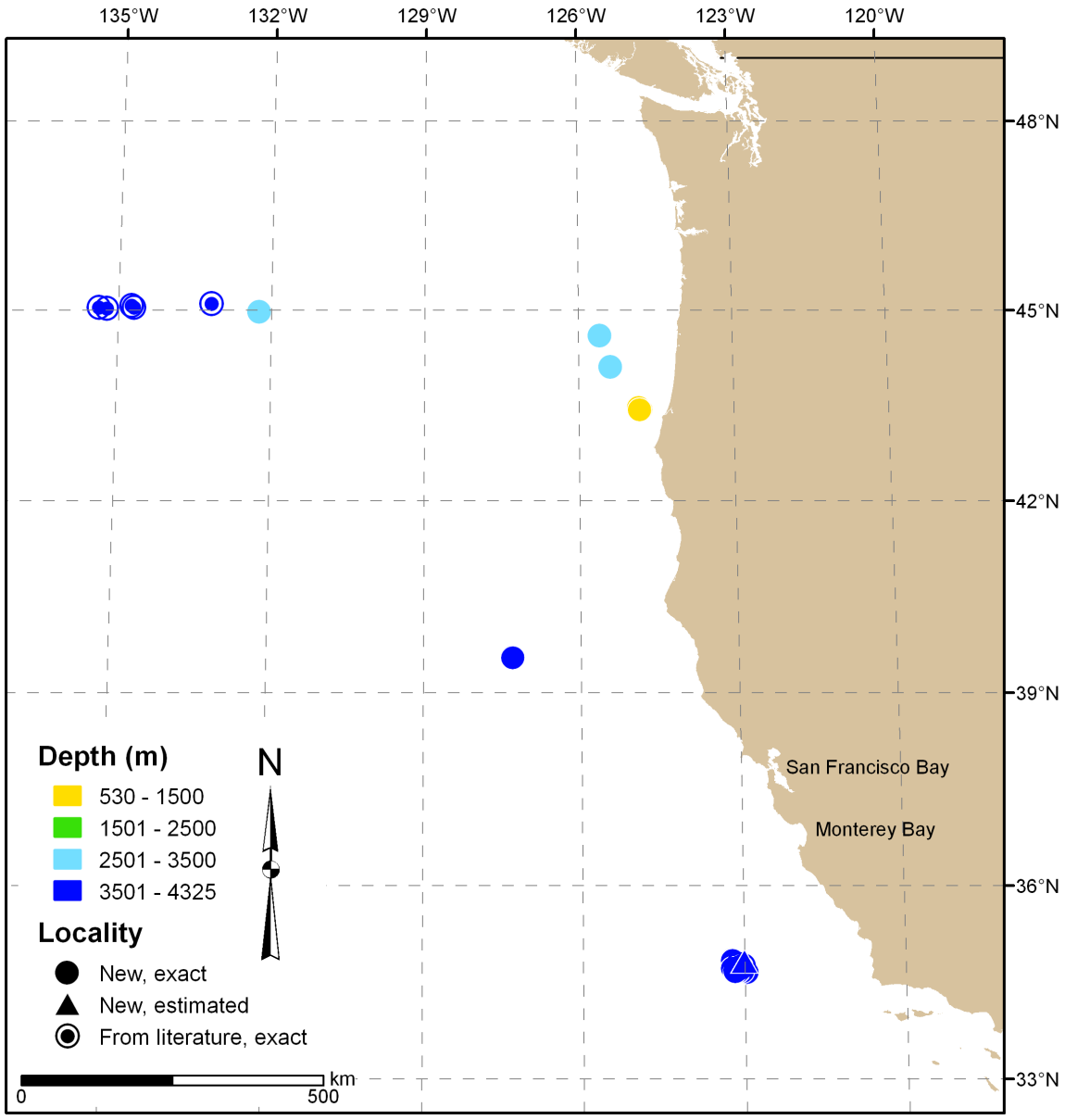

Figure 17. Distribution of *Anthosactis nomados* from California to Oregon.

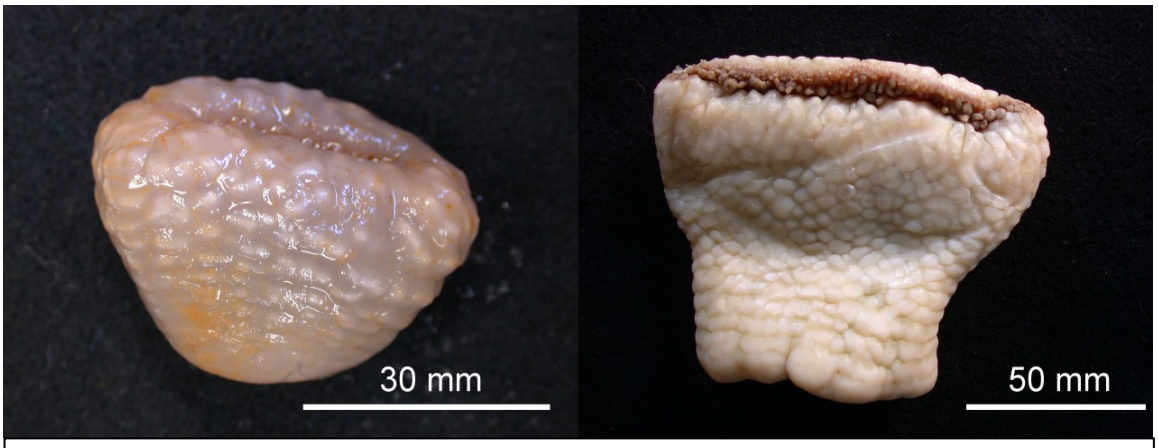

Figure 18. Specimens of *Paractinostola faeculenta.* Small specimen on left (KUBI 003301) Large specimen on right (KUBI 001459)

***Paractinostola faeculenta* (McMurrich, 1893)**

Description. Specimens typically lacking ectoderm; purple to white mesoglea exposed (Figure 18). Column thick, slightly transparent and lumpy and in smaller specimens; lumpy column opaque, appears melted in larger specimens. Column tapers from distal to proximal end. Oral and pedals discs concave; pedal discs appear to have once grasped mud or rock for anchorage. Column from approximately 14 mm wide and 15 mm long, to 140 mm wide and 110 mm long. Three to five cycles of mesenteries at mid-column; to three cycles of mesenteries complete (third cycle complete only distally). Two cycles of mesenteries sterile, third to fifth cycle may be fertile. Additional small, thin mesenteries at only extreme proximal end, could not be counted. Number of mesenteries inferred to be equal to number of tentacles; to more than 200 longitudinally furrowed tentacles. Marginal tentacles short and tightly packed; discal tentacles long and dispersed over oral disc. For a detailed description of *P. faeculenta,* see McMurrich (1893) and Carlgren (1934).

Cnidae. Spirocysts, basitrichs, microbasic *p*-mastigophores, and microbasic *b*-mastigophores. Sizes and distribution of cnidae shown in Table 4, illustrated in Figure 19.

Discussion. In the original description of the species, McMurrich (1893) did not comment of the pattern of mesentery fertility because he could not find gametogenic tissue. When Carlgren (1934) re-examined the type specimens he, too, was unable to detect gametogenic tissue; he moved the species to the genus *Paractinostola,* but its position in the group has remained questionable due to lack of information on the animals' fertility.

In the specimens that I examined, the mesenteries of the first two cycles were complete and sterile (as is diagnostic of the genus) and those of the third to fifth cycles were typically fertile. Thus I confirm the placement of the species in genus *Paractinostola*. Mesenteries of the third cycle were also complete but only at the extreme distal end.

Specimens of *Paractinostola faeculenta* I examined agreed with both McMurrich (1893) and Carlgren (1934), except for the form of their pedal disc and number of tentacles and mesenteries. Specimens that I examined possessed a concave pedal disc; the type specimens possessed an adherent base. The large animals that I examined had more tentacles (over 200) than the type specimens (~150). Smaller specimens that I examined had approximately the same number of tentacles as the type specimen; therefore, it appears as though number of tentacles (and likely mesenteries) increases with size.

Paractinostola faeculenta was described from six specimens collected north of the Channel Islands, California, USA (McMurrich 1893). I have examined additional

specimens of *P. faeculenta* from southern California, north to British Columbia, and west to Japan from depths of 82 m [45 fm] to 2,265 m (Figure 20). *Paractinostola faeculenta* lives in the MW, intermediate water, and NPDW of the northeastern Pacific Ocean.

Specimens Examined. See Appendix 9.

Tissue and Cnida Type	Length x Width (µm)	n	N
Tentacles			
Gracile Spirocysts (a)	20.2-50.4 x 2.6-5.3	105	4/4
Robust Spirocysts (b)	(24.9) 27.2-58.5 (62.2) x 3.2-7.5 (7.9)	103	4/4
Basitrichs (c)	19.9-33.5 (37.2) x 1.9-3.1	138	4/4
Microbasic *p*-mastigophores (d)	17.3-26.0 (27.4) x 3.1-5.4	91	4/4
Microbasic *b*-mastigophores (e)	38.5-56.9 x 6.5-10.8	70	3/4
Actinopharynx			
Basitrichs (f)	22.4-31.2 x 2.3-3.1	31	3/3
Microbasic *p*-mastigophores (g)	19.9-26.9 (30.9) x 3.4-5.4	27	3/3
Mesenterial Filaments			
Basitrichs (h)	(23.0) 24.4-33.9	31	3/3
Microbasic *p*-mastigophores (i)	18.4-28.3 x 4.1-6.1 (6.9)	30	3/3

Table 4. Cnidae size and distribution of *Paractinostola faeculenta*.

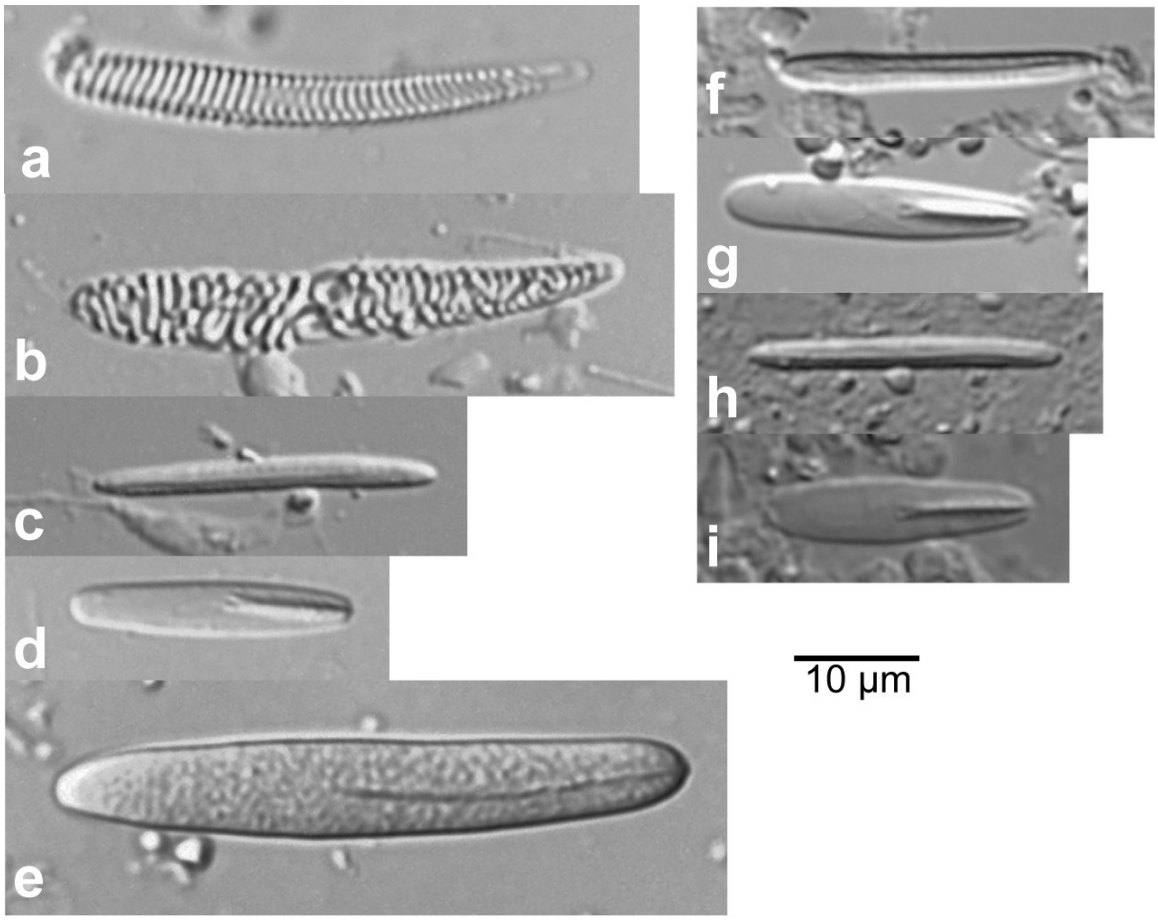

Figure 19. Cnidae of *Paractinostola faeculenta*. Correspond to letters in Table 4.

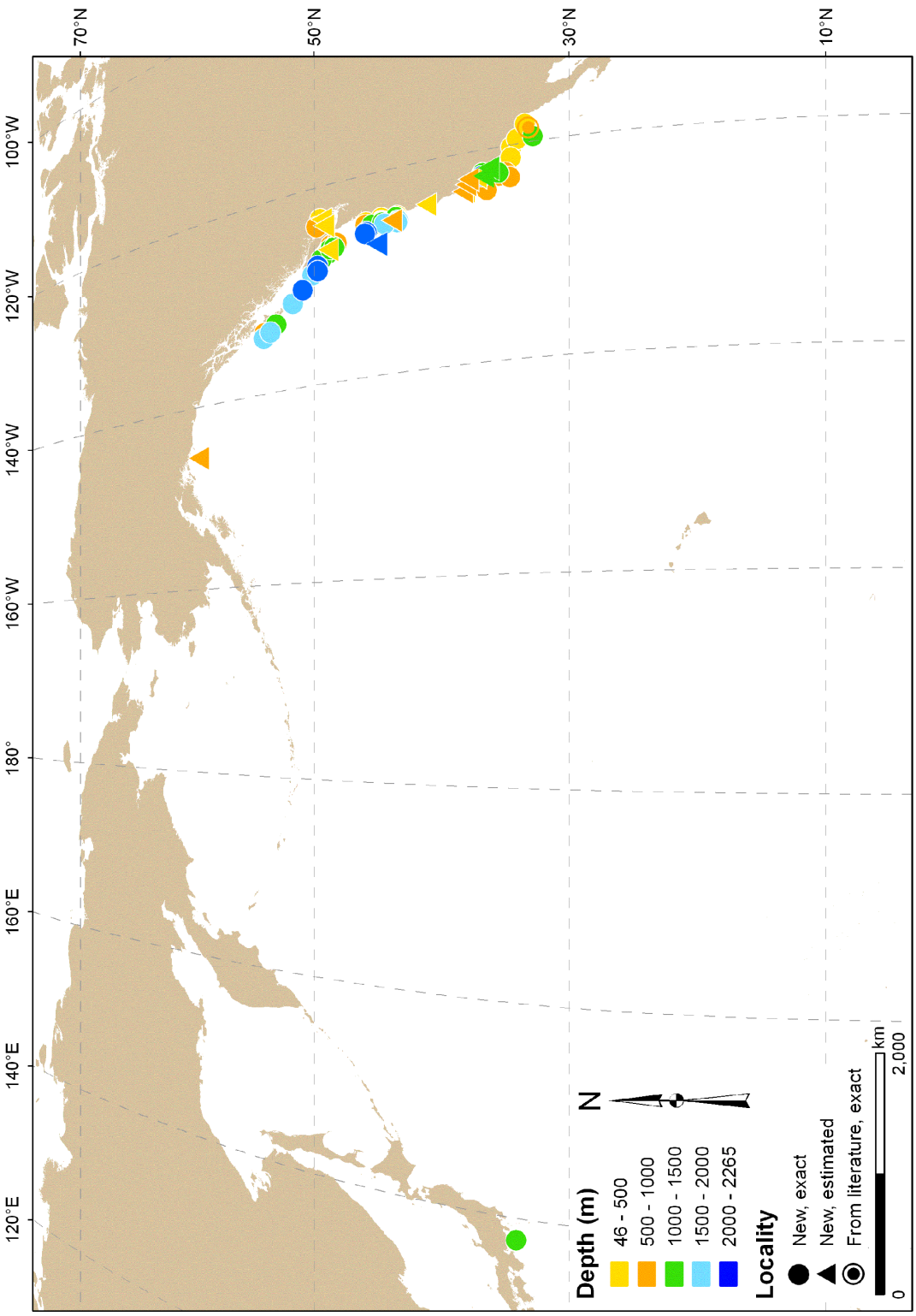

Figure 20. Distribution of *Paractinostola faeculenta* in North Pacific Ocean.

***Sicyonis careyi* n. sp.**

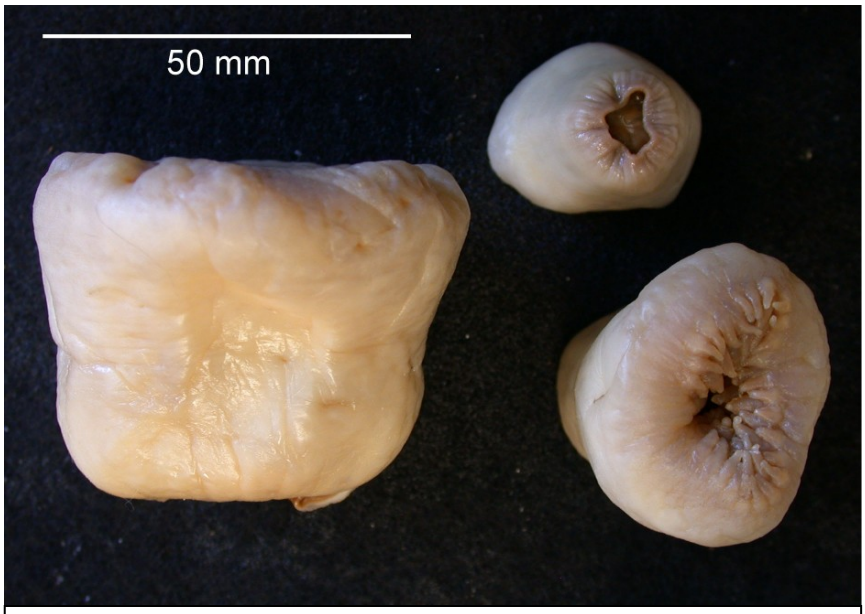

Figure 21. Specimens of *Sicyonis careyi* n. sp. (SBMNH 422541).

Body Form and Size. Column of specimens white to light grey (color of exposed mesoglea). Stiff due to thick mesoglea (to 6 mm mid-column in specimen 39 mm long); smooth except for few shallow irregular furrows; mesenterial insertions rarely visible. Cylindrical column of preserved specimens may be slightly compressed laterally (likely due to compression in net when collected), tentacles partially hidden in all specimens examined. Oral and pedal disc approximately same diameter, or column may taper slightly from oral to pedal disc (Figure 21). Column of most specimens examined 33-56 mm long, shortest 10 mm long.

Pedal Disc. Pinkish brown; smooth with rare furrows where mesenteries insert near limbus. Typically 24-42 mm diameter (7 mm diameter in smallest specimen); concave, concavity reaching 16 mm long, disc typically grasping a bolus of mud.

Oral Disc and Tentacles. Tan or brown, radially furrowed where mesenteries insert; hidden by tentacles and contracted column in all specimens examined. Diameter 34-48

mm (13 mm in smallest), roughly same diameter as column length. Mouth same color as disc, approximately 1/3 diameter of oral disc; two large white siphonoglyphs apparent.

Tentacles tan, circumferentially furrowed, bases slightly thickened aborally (Figure 22a); arrayed in 3 cycles, approximately 80 in number (58 in smallest specimen). Inner tentacles endocoelic and larger than outer (exocoelic); short, pointed, 2-8 mm long, taper from 2-4 mm at base to 0.5-1 mm at tip. Small pore at tip (Figure 22b) more apparent in endocoelic than exocoelic tentacles.

Internal Anatomy. Actinopharynx tan, brown, or grey, long, longitudinally sulcate. Two deep, white siphonoglyphs present; attach to two pairs of directive mesenteries.

Mesenteries thin and numerous (approximately 80 pairs), irregularly arrayed; incomplete mesenteries loosely follow *Actinostola* rule. Mesenteries of youngest cycle very thin and weak, exist only at extreme proximal end, lack filaments, and possess gametogenic tissue (Figure 22c). All other mesenteries muscular with filaments and possess large mesogleal thickenings distally (Figure 22d). Mesenteries of second youngest cycle (typically 20 pairs) extend from pedal to oral disc but very small compared to those of older cycles; rarely possess gametogenic tissue. Oldest mesenteries (typically 20 pairs) long and typically complete, although only one member or rarely both members of a pair incomplete; contain oral but no marginal stomata.

Muscular mesenteries possess long, diffuse retractor muscles. Parietobasilar muscles weak, lack a pennon.

Mesogleal marginal sphincter weak and moderately long; lies against endoderm (Figure 22e). Occupies less than half column width distally; alveoli large and loosely

arrayed. Sphincter tapers proximally; more reticular towards endoderm, alveolar towards ectoderm. Sphincter may be longitudinally striated distally.

Longitudinal musculature of tentacles mesogleal and well developed (Figure 22a).

Cnidae. Spirocysts, basitrichs, holotrichs, and microbasic *p*-mastigophores. Sizes and distribution of cnidae shown in Table 5, illustrated in Figure 23.

Etymology. Named in honor of Andrew Carey who collected this species, as well as many other deep-sea anemones, off the coast of Oregon.

Discussion. *Sicyonis careyi* n. sp. appears to be endemic to the northeastern Pacific where it occurs in intermediate water, NPDW, and CDW from 550 to 3,700 m (Figure 24). No other member of the genus is known from the northeastern Pacific. However, any discussion of the genus *Sicyonis* should include the genera *Parasicyonis* and *Synsicyonis*, as members of the three genera can easily be confused with one another.

Members of the genus *Synsicyonis* are differentiated from members of *Sicyonis* by the position of the last cycle of mesenteries (which is fertile and lacks filaments); the last cycle occurs only at the extreme distal end of the column in members of *Synsicyonis* and at the extreme proximal end of the column in members of *Sicyonis*. The only species of the genus *Synsicyonsis*, *S. elongata*, is known from the middle of the North Pacific from 5,304 m [2,900 fm] and its youngest cycle of mesenteries are only at the distal end and are muscular.

The youngest cycle of mesenteries is fertile in members of *Parasicyonis* and *Sicyonis*; however, those of *Parasicyonis* contain mesenterial filaments, and those of *Sicyonis* lack mesenterial filaments.

In describing *Sicyonis biotrans,* which possesses small filaments on mesenteries of the youngest cycle, Riemann-Zürneck (1991) argued that this character is not stable; however, she did not provide evidence for this assertion, and did not change the definition of the genus *Sicyonis*. Because the presence or absence of filaments on mesenteries of the youngest cycle is the only characteristic distinguishing the genera, the species she described is properly *Parasicyonis biotrans* (Riemann-Zürneck, 1991).

Specimens Examined. See Appendix 10.

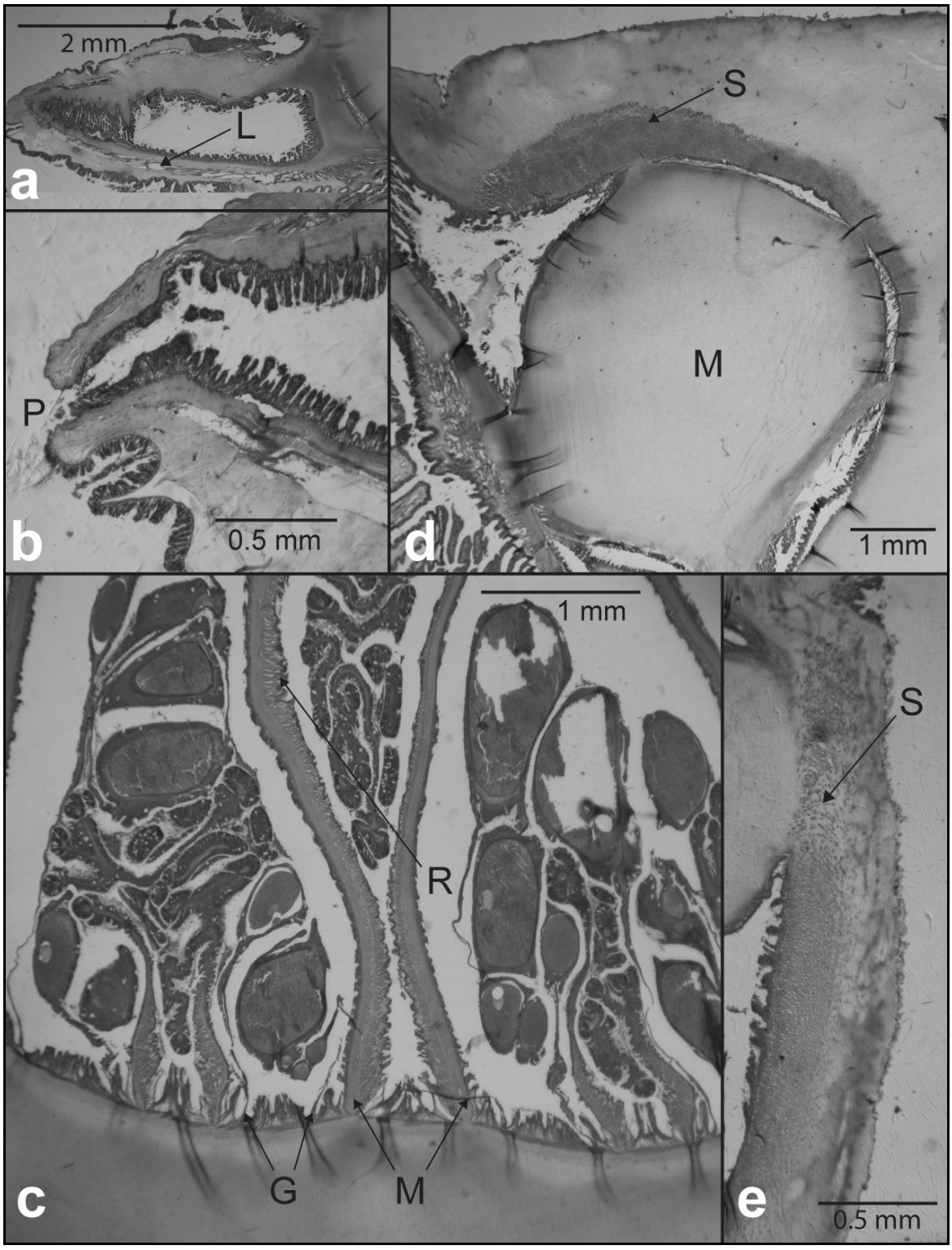

Figure 22. *Sicyonis careyi* n. sp. a. Tentacle with mesogleal longitudinal musculature (L); b. tentacle pore (P); muscular mesenteries (M) with diffuse retractor muscles (R) and thin gametogenic mesenteries (G); d. mesogleal marginal sphincter muscle (S) and thickened mesoglea at distal end of mesenteries (M); e. mesogleal marginal sphincter muscle (S).

Tissue and Cnida Type	Length x Width (µm)	n	N
Tentacles			
Gracile spirocysts (a)	25.3-49.9 (54.3) x 2.9-4.8 (5.2)	33	3/3
Robust spirocysts* (b)	(33.0) 35.4-50.9 (55.9) x (4.4) 4.8-6.0	17	3/3
Basitrichs (c)	27.6-45.5 x 3.3-4.2	37	3/3
Holotrichs (d)	25.9-47.0 x (3.2) 3.4-4.3 (4.6)	42	3/3
Actinopharynx			
Basitrichs (e)	32.3-43.3 (46.2) x 3.2-4.5 (4.8)	34	3/3
Microbasic *p*-mastigophores (f)	22.9-29.9 x 4.9-6.0	30	3/3
Mesenterial Filaments			
Basitrichs (g)	26.2-35.9 x 5.0-6.8	31	3/3
Microbasic *p*-mastigophores (h)	(15.2) 18.5-32.1 x 4.1-6.3 (6.8)	31	3/3

Table 5. Cnida size and distribution of *Sicyonis careyi* n. sp. Length appears to depend on size; shorter specimens tend to have smaller cnidae. * Sparse.

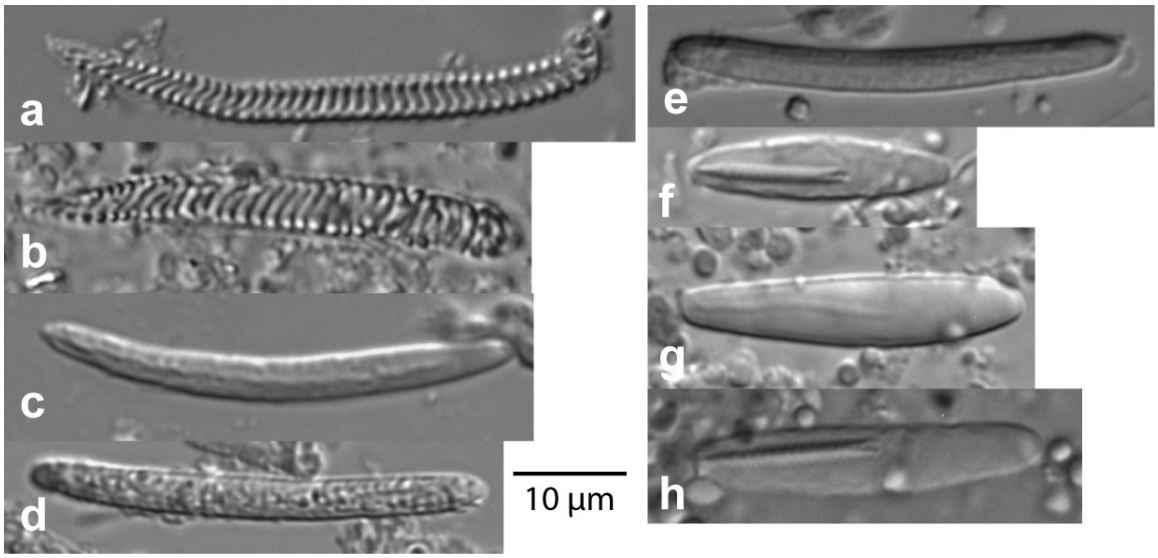

Figure 23. Cnidae of *Sicyonis careyi* n. sp. Correspond to letters in Table 5.

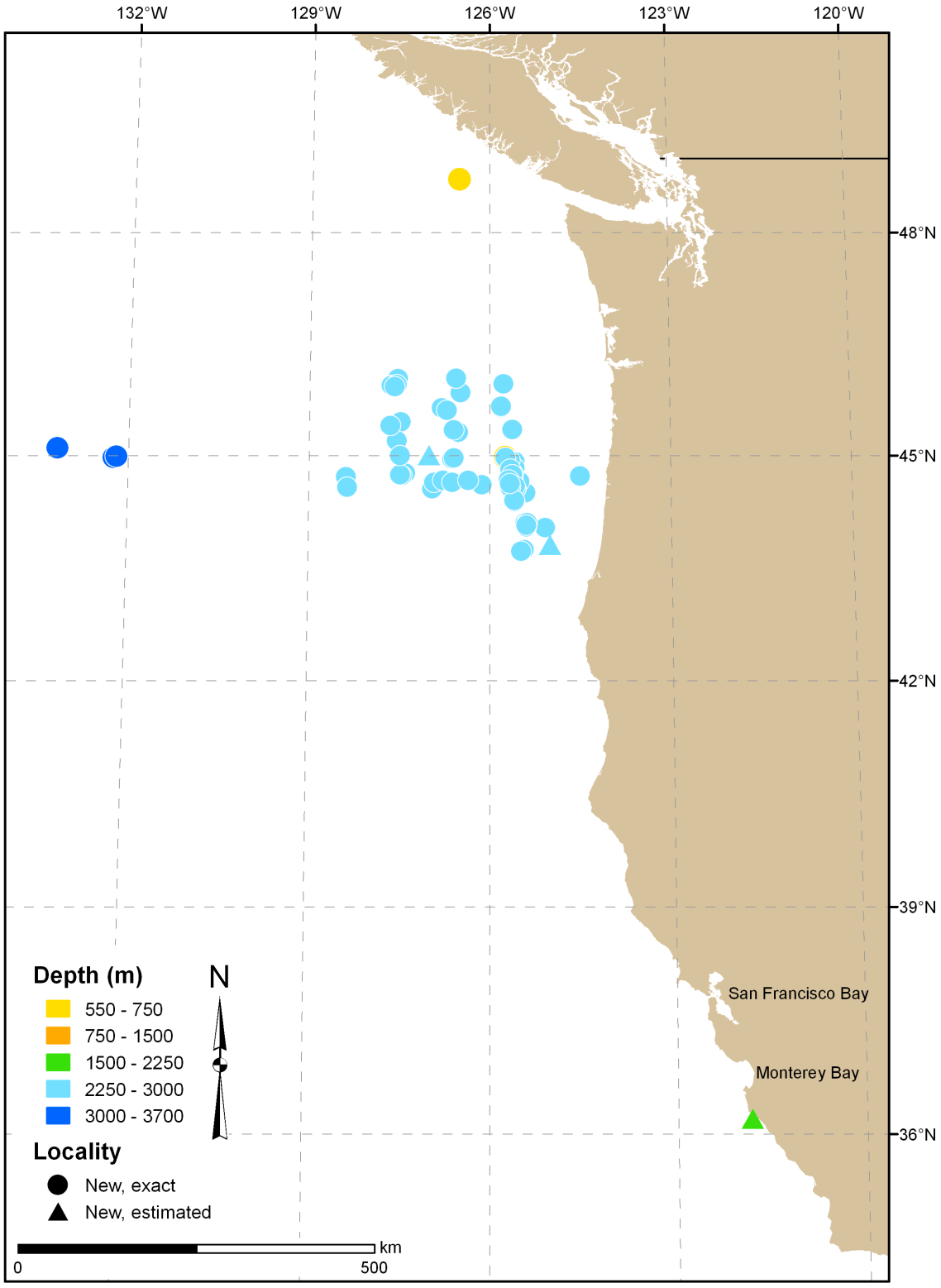

Figure 24. Distribution of *Sicyonis careyi* n. sp. from California to British Columbia.

Differential Diagnosis. *Sicyonis careyi* n. sp. can be distinguished from its congeners by its combination of: smooth mesoglea; smooth and thin pedal disc; weak alveolar marginal sphincter; oral stomata; approximately 80 aborally thickened tentacles; approximately 80 pairs of mesenteries, of which those of the youngest and rarely the penultimate cycle are fertile; size and distribution of cnidae.

Dichotomous Key of *Sicyonis*

1. Tentacles thickened at base by mesoglea.…….2

- Approximately 70 tentacles; not thickened at base. Approximately 100 pairs of mesenteries, to 21 pairs complete, some additional pairs with only one member complete; oral and marginal stomata present. North Atlantic Ocean…..….*S. variabilis*

2. More than 100 tentacles……...…3

- Fewer than 100 tentacles……...……...4

3. Approximately 144 tapered tentacles, of differing lengths, aborally thickened. 144 pairs of mesenteries. North Atlantic Ocean……...…...…….....*S. gossei*

- Approximately 200 large tentacles, all same length, aborally thickened. To five cycles of mesenteries. Off Japan..……..……...……..……....*S. tubulifera*

4. Tentacles aborally thickened, but not projecting as large swollen bulbs…….5

- Tentacles aborally thickened, mesoglea projecting as large swollen bulbs. Marginal sphincter muscle mesh-like interrupted by strips of mesoglea. Oral and marginal stomata present; marginal only on stronger mesenteries. Rarely some mesenteries of penultimate cycle also fertile. North Atlantic Ocean..….. *S. tuberculata*

5. Marginal sphincter muscle well developed, half or more of width of mesoglea…….6

- Marginal sphincter muscle poorly developed, less than half width of mesoglea……..7

6. Youngest mesenteries fertile, exist only near base. Column smooth, with shallow furrows distally; marginal sphincter long, reticular near endoderm, alveolar near ectoderm. North Atlantic Ocean……..…… *S. hemisphaerica*

- Youngest mesenteries fertile, extend far distally. Column smooth; marginal sphincter muscle long, striated and reticular. Off Indonesia……...…*S. sumatriensis*

7. Tentacles conical……..…8

- Tentacles wart-like. Column short with deep constriction in center. No microbasic *p*-mastigophores in actinopharynx. Southern Indian Ocean……..…. *S. crassa*

8. Only youngest cycle of mesenteries fertile; column longitudinally furrowed distally…9

- Youngest cycle, as well as some young muscular mesenteries fertile; column not longitudinally furrowed distally. One size class of basitrichs in mesenterial filaments……...10

9. Marginal sphincter more alveolar than reticular, not stratified. Column approximately twice as wide as long. Fifteen pairs of mesenteries complete, plus one additional member of a single pair complete. North Atlantic Ocean…….…… *S. obesa*

- Marginal sphincter alveolar and stratified. Column only slightly wider than long. At least 16 pairs of mesenteries complete; single members of additional mesentery pairs may be complete. Oral and marginal stomata present; marginal stomata typically on only stronger mesenteries. North Atlantic Ocean……..…...… *S. ingolfi*

10. Column smooth, typically circumferentially furrowed proximally, pink to red ectoderm typically in furrows; mesoglea fibrous distally. Oral stomata present. Pedal disc brown, thick, furrowed. Marginal sphincter reticular. Microbasic *p*-

mastigophores present in actinopharynx; basitrichs of mesenterial filaments 13.1-19.7 μm long. Southern Ocean…..…… *S. erythrocephala*

-Column white, smooth, only with very shallow irregular furrows (likely artifact of collection method), devoid of ectoderm; mesoglea smooth, not fibrous. Oral stomata present. Pedal disc pinkish-brown, furrowed only near limbus, thin. Marginal sphincter with large alveoli distally; proximally reticular towards endoderm, alveolar towards ectoderm. Microbasic *p*-mastigophores in actinopharynx; basitrichs of mesenterial filaments 26.2-35.9 μm long. Northeastern Pacific Ocean... ……*S. careyi* n. sp.

Family Bathyphellidae

Bathyphellia australis

Dunn, 1982

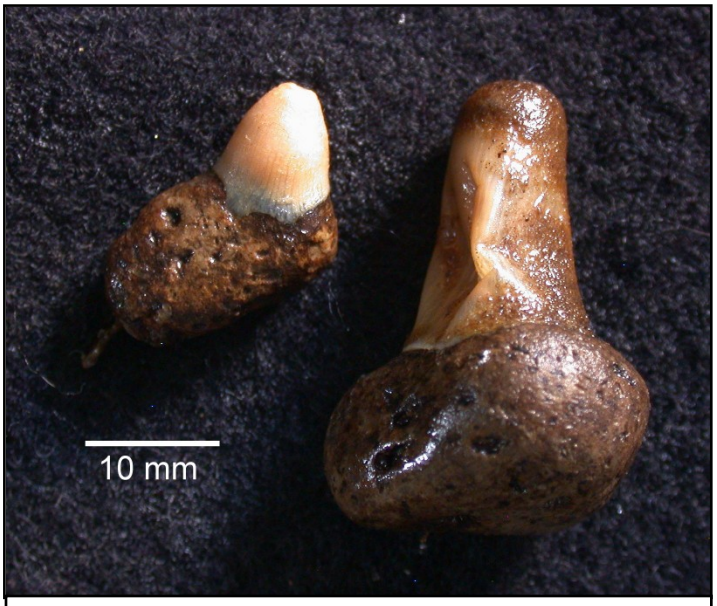

Figure 25. Specimens of *Bathyphellia australis* each attached to a manganese nodule (KUBI 002167).

Description. Elongate column (to ~ 30 mm) tapered distally. Scapus rough, dark, covered in tenaculi holding cuticle and typically debris; when sloughed off, scapus tan, smooth. Margin of most specimens contracted, covers oral disc. Pedal disc typically attached to manganese nodule (Figure 25). Mesenteries in three cycles, all with somewhat restricted diffuse retractor muscles; six pairs of macrocnemes. Acontia small, difficult to locate (commonly members of family Bathyphellidae have reduced or apparently absent acontia [Carlgren 1956; Dunn 1983; Riemann-Zürneck 1997]). For a detailed description of *B. australis,* see Dunn (1983).

Cnidae. Spirocysts, basitrichs, and microbasic *p*-mastigophores.

Discussion. Riemann-Zürneck (1997) moved *B. australis* to the genus *Daontesia* because in her opinion the presence of a multistratified cuticle was the most taxonomically important character. However, because of the shape of the retractor muscles (somewhat

restricted), number of macrocnemes (six), and cnidae, *B. australis* most closely resembles the type species *B. margaritacea* and should remain in the genus *Bathyphellia.*

Bathyphellia australis was originally described from specimens collected from the Southern Ocean (Dunn 1983). It also occurs in NPDW and CDW of the northeastern Pacific from California to Oregon. Specimens found from depths of 2,709 to 4,575 m (Figure 26).

Specimens Examined. See Appendix 11.

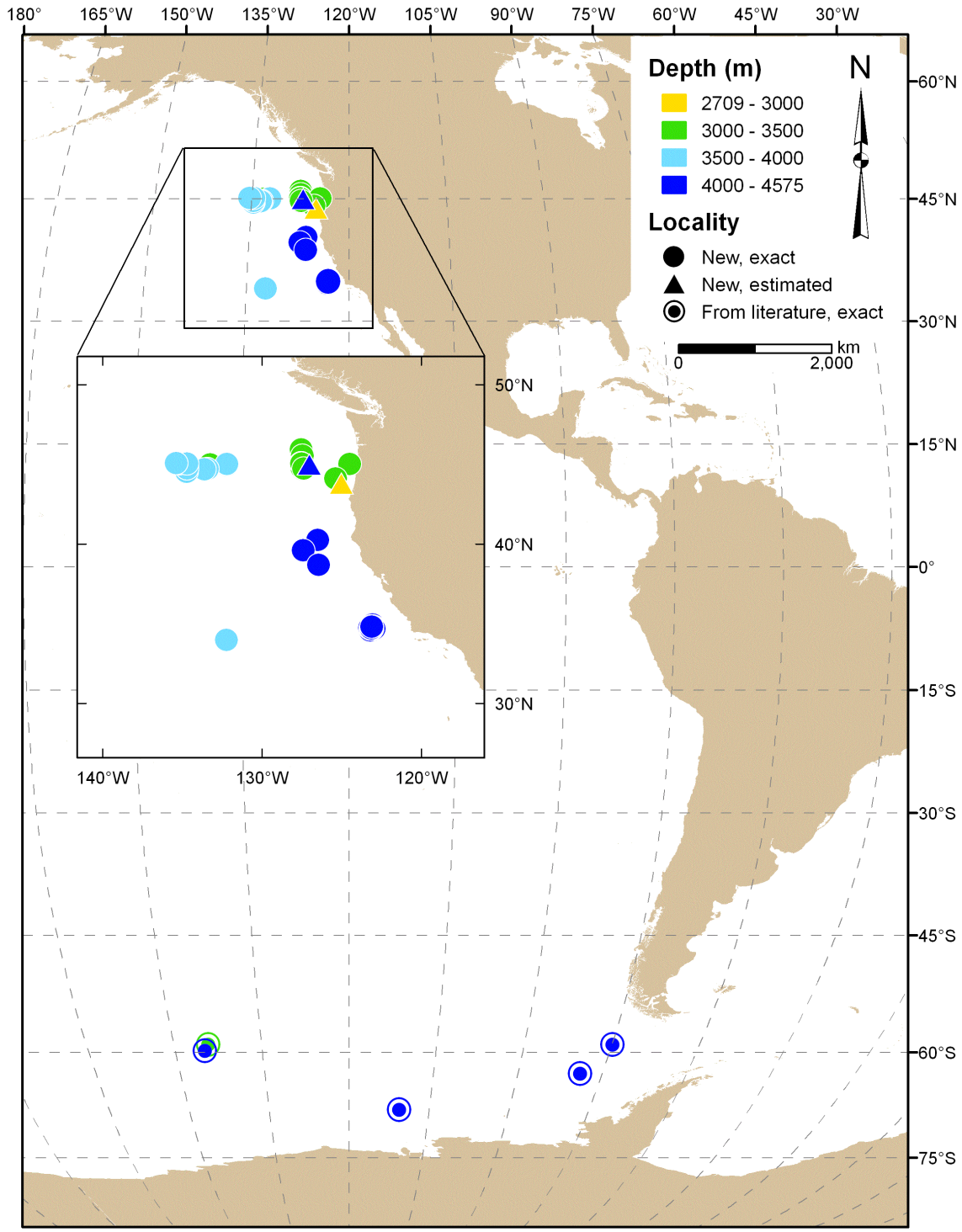

Figure 26. Distribution of *Bathyphellia austrialis* in Southern and northeastern Pacific Ocean.

Figure 27. Specimens of *Actinauge verrillii*. Specimen on left (SBMNH 422707) attached to worm tube. Specimen on right is a syntype (USNM 17807).

Family Hormathiidae

***Actinauge verrillii* McMurrich, 1893**

Description. Column varies in shape depending on object attached to: most attached to either gastropod, cylindrical object such as worm tube or sponge spicules, or bolus of mud. Column to 46 mm long; scapus covered in tubercles. Tubercles small toward base, more pronounced toward margin; brown cuticle typically remains only in furrows between tubercles (Figure 27). Specimens with column contracted, hiding oral disc; tentacles rarely visible. Same number of tentacles as mesenteries (~96 or four cycles); tentacles tapered, aborally thickened. For detailed descriptions of *A. verrillii,* see McMurrich (1893) and Dunn (1983).

Cnidae. Spirocysts, basitrichs, and microbasic *p*-mastigophores.

Discussion. *Actinauge verrillii* was originally described from 15 specimens collected from off the Galapagos Islands, Chile, and the Channel Islands of California from 717, 1,238, and 757 m [392, 677, and 414 fm], respectively (McMurrich 1893). Specimens have also been discovered in the north Atlantic and Southern oceans and have been collected in from trawls at 0-425 m to 4,250 m (Figure 28). *Actinauge verrillii* appears to be a cosmopolitan species that can be found within all water masses in the northeastern Pacific Ocean.

Specimens Examined. See Appendix 12.

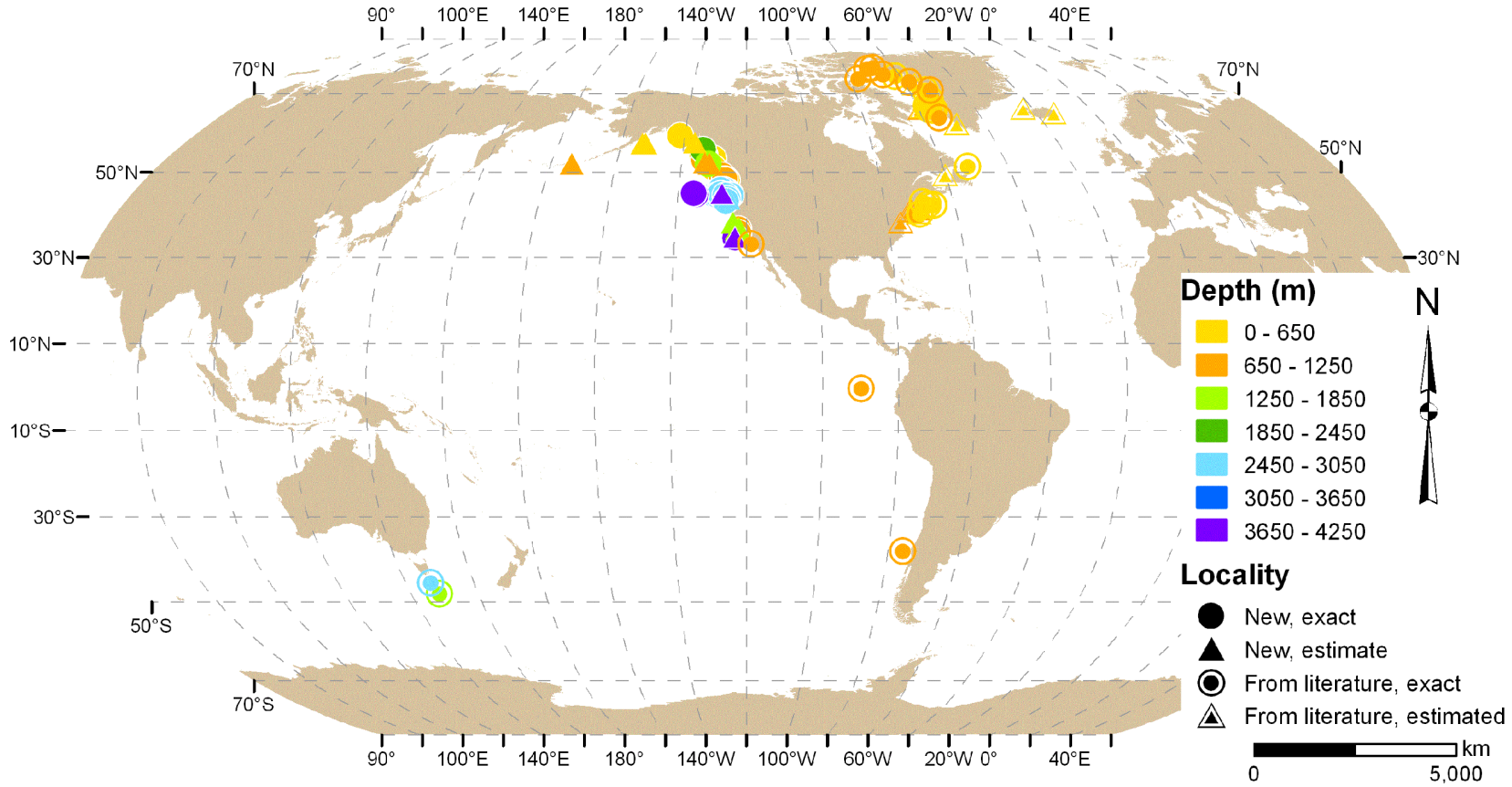

Figure 28. Distribution of *Actinauge verrillii* in Southern, Atlantic, and Pacific Oceans

***Monactis vestita* (Gravier, 1918)**

Figure 29. Specimens of *Monactis vestita* with a variety of body forms (KUBI 001210)

Distribution. Body form (Figure 29) presumably depends on object attached to (gastropod, rock, cylindrical object); body tall, flat, or elongate. Diameter of pedal disc to approximately 40 mm; length of column to 18 mm. Column tan, smooth; margin typically contracted so oral disc hidden. Approximately 32 tentacles; may be hidden by contracted margin. Mesenteries arrayed in four cycles; only first cycle complete and with acontia. Acontia difficult to distinguish from filaments. For detailed descriptions of *M. vestita,* see Gravier (1918), Riemann-Zürneck (1986), Zamponi and Acũna (1992), and White *et al.* (1999).

Cnidae. Spirocysts, basitrichs, and microbasic *p*-mastigophores.

Discussion. *Monactis vestita*, the only species in its genus, was originally described from specimens collected from the northeastern Atlantic Ocean from 2,286 and 5,005 m (Gravier 1918). The animals have also been found off the coasts of Venezuela (Riemann-Zürneck 1986) and Oregon (White *et al.* 1999). Specimens have been collected from

NPDW and CDW in the northeastern Pacific, and in the Atlantic and Pacific Oceans from 59 to 5,320 m (Figure 30).

Specimens Examined. See Appendix 13.

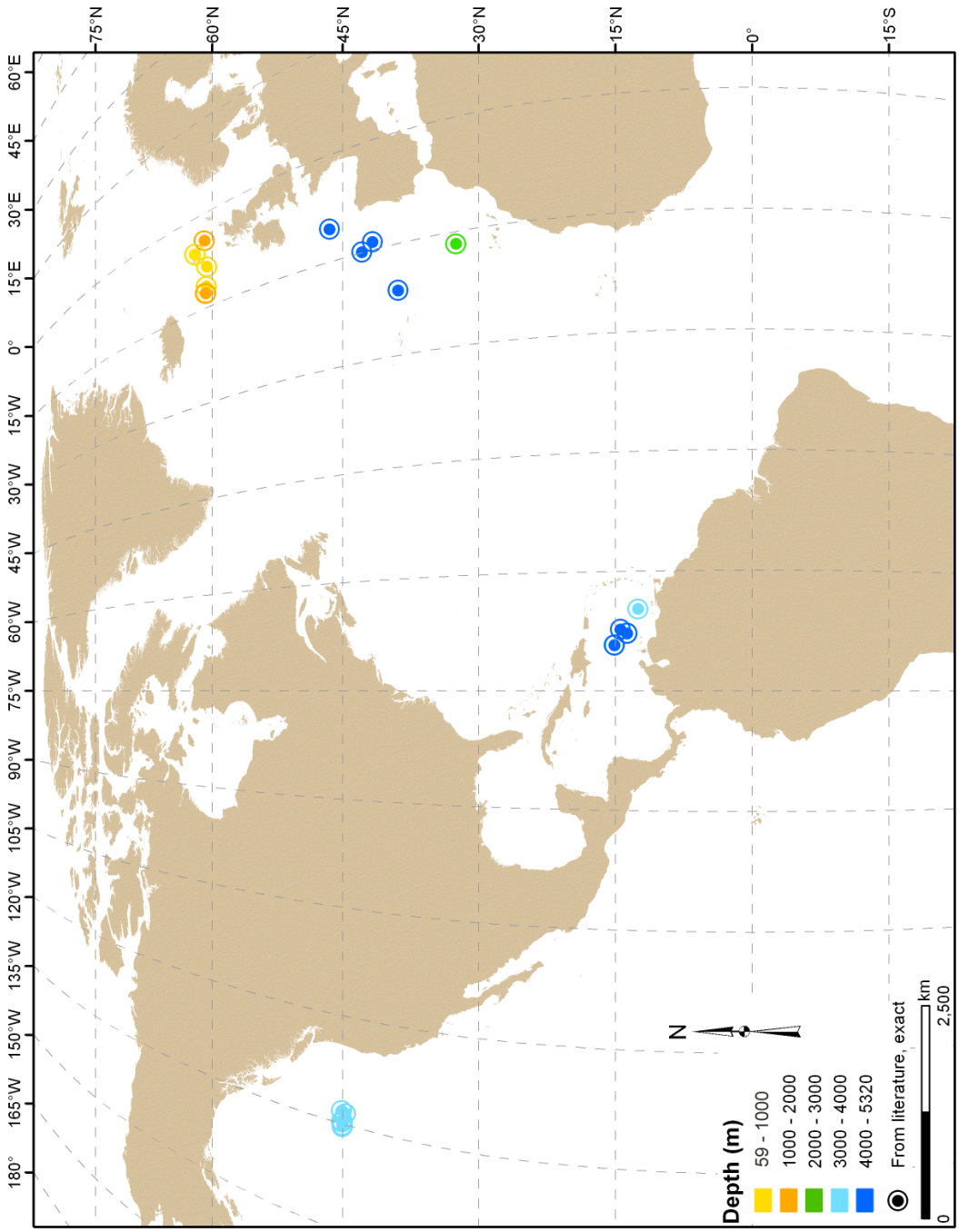

Figure 30. Distribution of *Monactis vestita* in North Atlantic and Pacific Oceans

Paraphelliactis pabista

Dunn, 1982

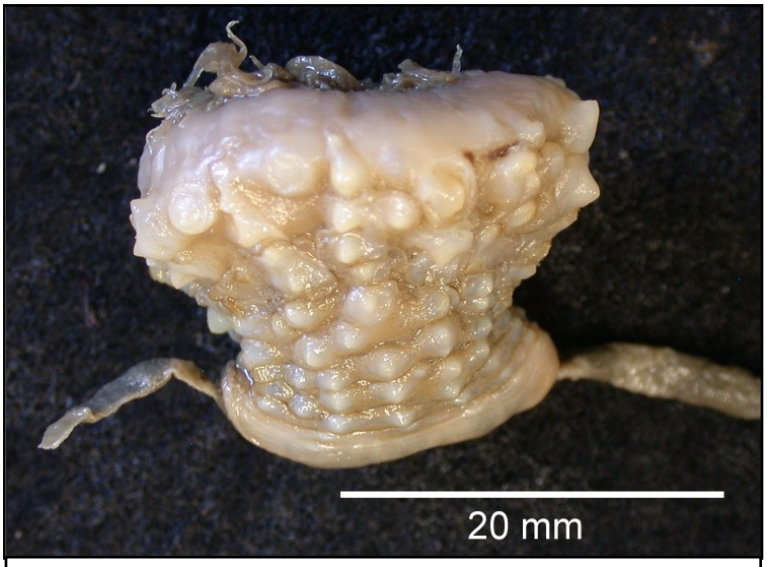

Figure 31. Specimen of *Paraphelliactis pabista* attached to worm tube (SBMNH 83609).

Description. Column light tan to brown, 10 to 80 mm long. Pointed tubercles of column arrayed in longitudinal rows along endocoels. Pedal disc often attached to a cylindrical object such as worm tube (Figure 31) or holds small stone or bolus of mud. Aborally thickened tentacles more numerous than mesenteries at mid-column (to more than 150 tentacles vs. 96 mesenteries). For detailed descriptions of *P. pabista,* see Dunn (1982) and Sanamyan and Sanamyan (2007).

Cnidae. Spirocysts, basitrichs, and microbasic *p*-mastigophores.

Discussion. The only other species of the genus (*P. spinosa* [type species] and *P. michaelsarsi*) were moved to the genus *Phelliactis* by Riemann-Zürneck (1973), making the genus invalid. However, Riemann-Zürneck (1973) did not report on the relation of the number of mesenteries to the number of tentacles in specimens of the two species, the key character in distinguishing the two genera. I agree with Sanamyan and Sanamyan (2007), who discuss this issue in detail, that *P. spinosa* and *P. michaelsarsi* should remain

in the valid genus *Paraphelliactis* unless it is determined that the arrangement of mesenteries in these species conforms to the definition of *Phelliactis*.

Paraphelliactis pabista was described from off the coast of British Columbia (Dunn 1982). (Additional specimens have been found as far south as Mexico and occur at depths of 1,600 to 4,100 m (Figure 32). *Paraphelliactis pabista* lives in the NPDW and CDW of the northeastern Pacific Ocean.

Specimens Examined. See Appendix 14.

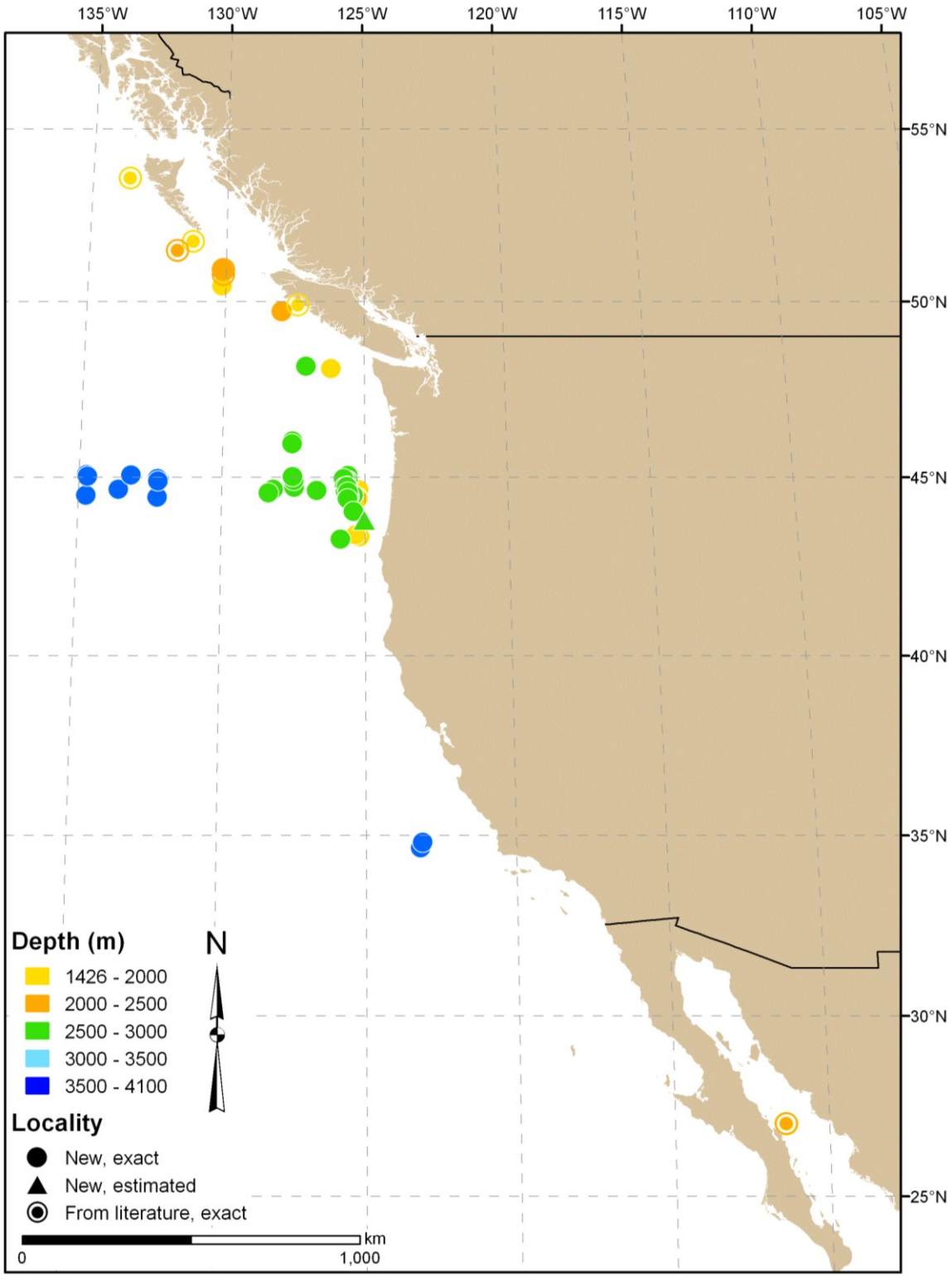

Figure 32. Distribution of *Paraphelliactis pabista* from Mexico to British Columbia.

Family Liponematidae

Liponema brevicorne

(McMurrich, 1893)

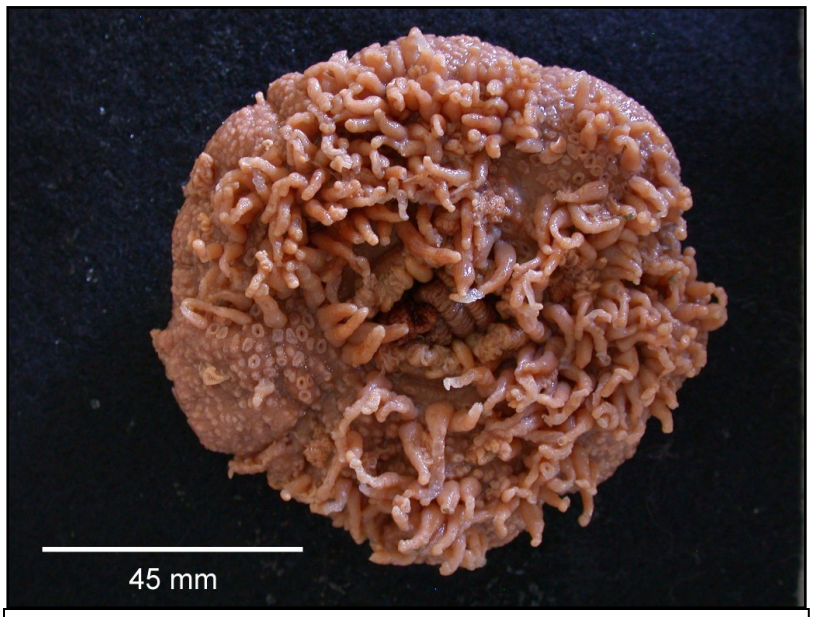

Figure 33. Oral disc of *Liponema brevicorne* missing approximately half of tentacles (KUBI 003280).

Description. Oral disc large; in preserved specimens tan to pink. Disc diameter to approximately 100 mm; expanded oral disc completely covers low column. Oral disc covered in short tentacles (Figure 33), one tentacle per endocoel, more than one per exocoel. Tentacles deciduous; can be pinched off by sphincter muscle at base of each tentacle. Bottoms of jars with preserved specimens often filled with detached tentacles. For detailed descriptions of *L. brevicorne,* see McMurrich (1893) and Dunn and Bakus (1977).

Cnidae. Spirocysts, basitrichs, and microbasic *p*-mastigophores.

Discussion. The original specific epithet given to this species was *brevicornis*. The proper first Latin declension neuter adjective form of the name is *brevicorne*.

Liponema brevicorne was originally described from north of the Channel Islands, 757 m [414 fm] deep (McMurrich 1893). Additional specimens have been collected throughout the North Pacific to the Aleutian Islands and Japan within intermediate water,

NPDW, and CDW at depths of 102 m [56 fm] to 4,134 m (Figure 34). In life, specimens are unattached to sea floor (Dunn and Bakus 1977).

Specimens Examined. See Appendix 15.

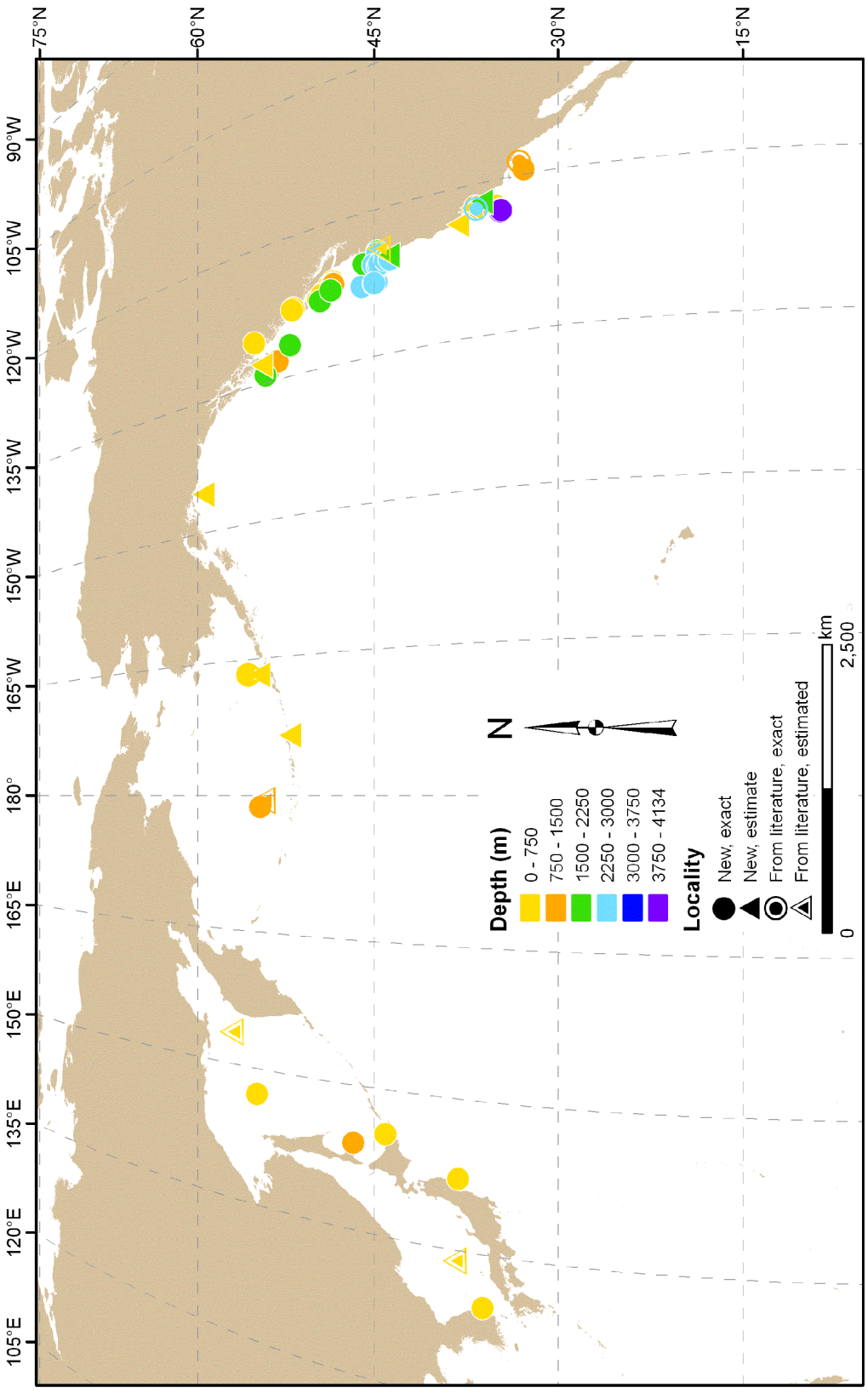

Figure 34. Distribution of *Liponema brevicorne*, from Southern California to Japan

Family Metridiinae

Metridium farcimen

(Brandt, 1835)

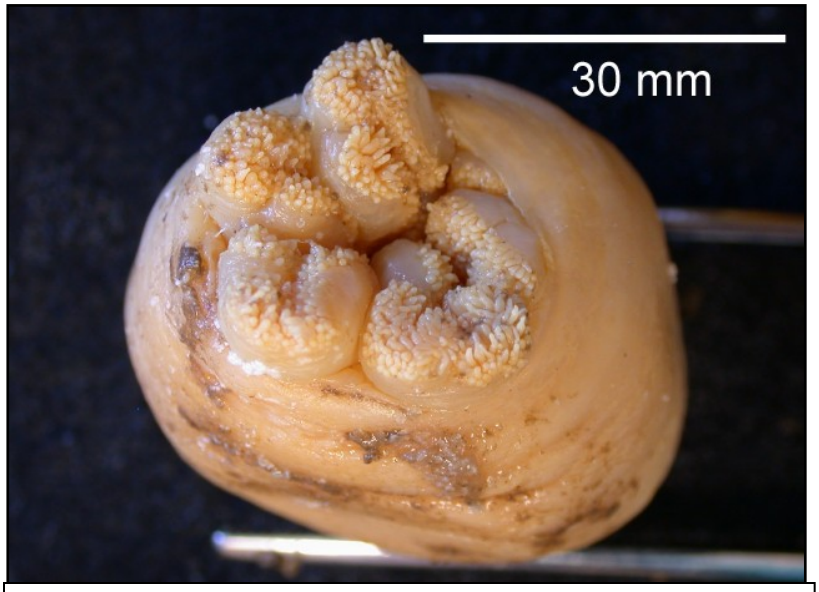

Figure 35. Oral view of *Metridium farcimen* showing stiffened lobes of oral disc (KUBI 001436).

Description. Specimens to 1 m long in life (Fautin *et al.* 1989); preserved specimens greatly contracted (to ~100 mm or less in length). Column smooth, white to pale salmon or brown. Margin typically contracted, partially or completely covering oral disc (Figure 35). Oral disc with lobes thickened with mesoglea. Disc covered in hundreds of tentacles; marginal tentacles shorter than discal tentacles. Pedal disc typically attached to rock or shell. For a detailed description of *M. farcimen,* see Fautin *et al.* (1989).

Cnidae. Spirocysts, basitrichs, microbasic *p*-mastigophores, and microbasic amastigophores.

Discussion. Fautin *et al.* (1989) described *Metridium giganteum*, a new species, and distinguished it from the two other species found along the northeastern Pacific coast (*M. senile* and *M. exilis*). However, several names had previously been applied to this species (Fautin and Hand 2000) so the valid name is *M. farcimen* (Brandt 1835).

Metridium farcimen has often been misidentified as its congener *M. senile*. Specimens of *Metridium farcimen* grow much larger than specimens of *M. senile,* which reach a maximum length of only 100 mm (Fautin *et al.* 1989). The oral disc of *M. farcimen* is divided into distinct stiffened lobes whereas the oral disc of *M. senile* has less distinct and flaccid lobes.

Metridium farcimen was described by Brandt (1835) from Kamchatka, Russia. Specimens have since been collected from subtidal waters to CDW (to 2,740 m) in the North Pacific from Mexico to Russia (Figure 36).

Specimens Examined. See Appendix 16.

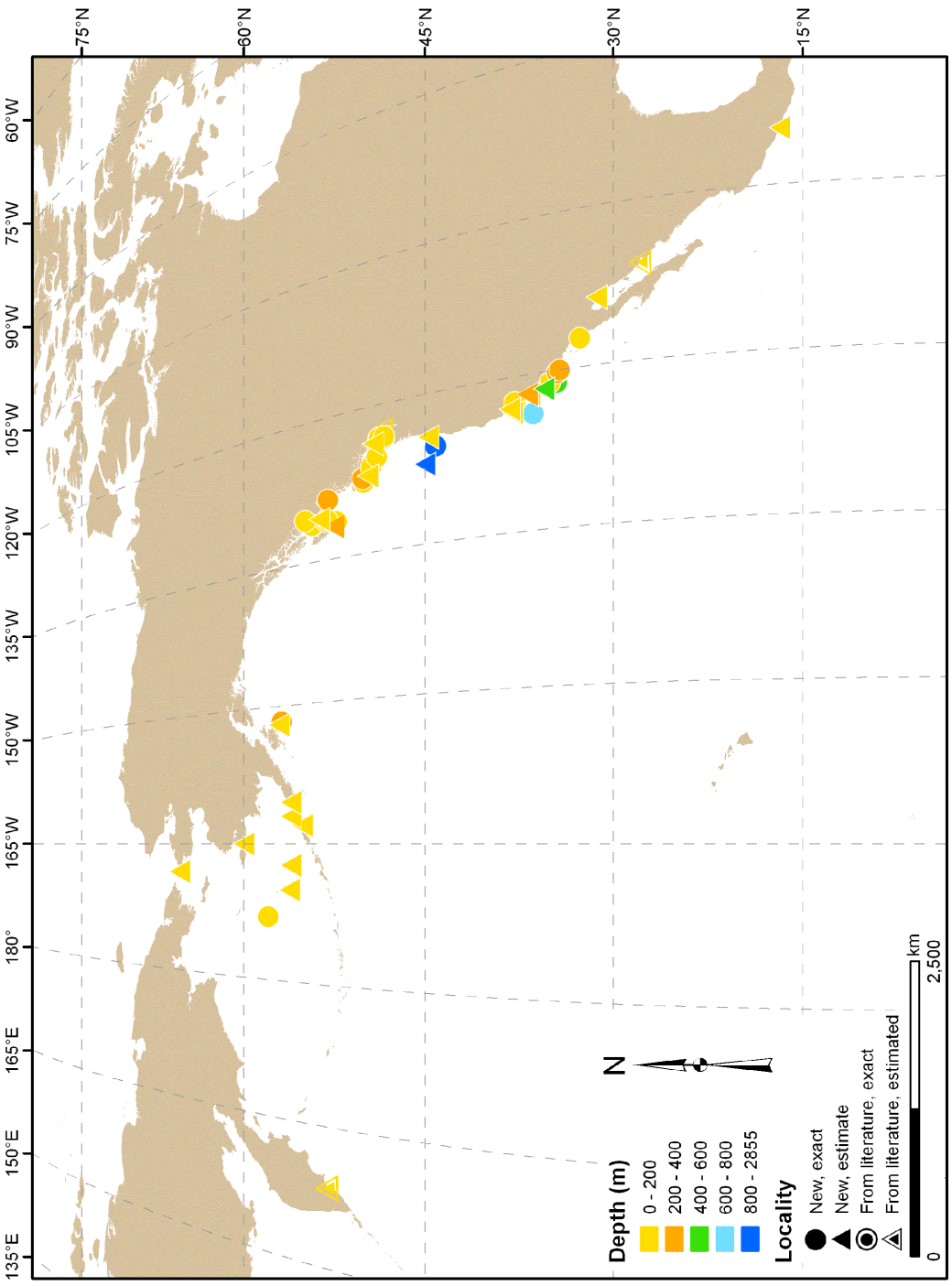

Figure 36. Distribution of *Metridium farcimen* from Mexico to Russia.

Figure 37. Oral view of two specimens of *Sagartiogeton californicus* showing variation in body form. Flat specimen of left (SBMNH 83608). Tall specimen on right (USNM 53337).

Family Sagartiidae

***Sagartiogeton californicus* (Carlgren, 1940)**

Body Form and Size. Column ectoderm tan or rose; in most specimens ectoderm sloughed off, mesoglea exposed. Mesoglea of scapulus white, thick (~1 mm), and cartilaginous. That of scapus thin; mesenterial insertions and purple endoderm of mesenteries (white in two specimens) apparent. Gametogenic tissue white, and filaments tan to purple. Purple endoderm and white gametogenic tissue give column a purple and white spotted appearance when ectoderm sloughed off (Figure 37). Sparse cinclides in distal part of scapus and near limbus.

Specimens short (approximately 3 mm long near mouth, 0.1 mm long at limbus) to approximately as tall as wide (to ~ 20 mm long), depending on contraction. Pedal disc typically wide; oral disc small and typically hidden along with bases of tentacles below

contracted margin of column. Pedal disc circular or slightly oval, to diameter of 47 mm. Oral disc (to ~14 mm diameter) much smaller than pedal disc.

Pedal Disc. Pedal disc off-white to tan; in most specimens slightly transparent with mesenterial insertions visible. Wide, concave in most specimens, shape depending on substrate; attached to shells, rocks, or crab exoskeleton. Most specimens with fine debris attached to disc, inferred to be from substrate. Some specimens with gastropod shell embossed on disc.

Oral Disc and Tentacles. Oral disc tan and smooth, mesenterial insertions may be visible. Approximately same shape as pedal disc (circular or slightly oval). In most specimens margin contracted so oral disc and bases of inner tentacles not visible.

Mouth approximately half oral disc diameter. Lips purple, slightly raised, radially furrowed. Position of two symmetrical siphonoglyphs evident externally by smaller lips and slightly lighter pigmentation.

Approximately 200 dark purple to white tentacles; ectoderm of outer tentacles typically sloughed away, dark purple endoderm visible through transparent mesoglea. Conical; 1-8 mm long, taper from 0.3-1 mm at base to <0.1 mm at tip. Tentacles arrayed in six cycles near margin (fewer tentacles in small specimens). Exocoelic tentacles outermost; shorter than inner (endocoelic) tentacles.

Internal Anatomy. Actinopharynx dark purple; long in tall specimens, short in flat specimens. Two off-white siphonoglyphs attach to two pairs of directive mesenteries.

Mesenteries typically with purple endoderm (pink to white in some specimens). Arrayed in five cycles; smaller specimens with fewer cycles (three cycles in flat specimen with pedal disc diameter of 8 mm). All mesenteries, except some of the youngest cycle, with filaments and gametogenic tissue. Mesenteries of first three cycles complete, with central stomata (see Arellano and Fautin [2001] for more information on central stomata). Mesenteries develop from proximal and distal end. Acontia present; either salmon or off-white with small purple spots. Diffuse retractor muscles small in weak mesenteries, well developed distally in stronger mesenteries (Figure 38a) and may be lobed. Parietobasilar muscles not apparent.

Mesogleal marginal sphincter muscle reticular, well developed, occupies most of mesoglea; separated from endoderm by thin strip of mesoglea (Figure 38b).

Longitudinal musculature of tentacles ectodermal, circular muscles not seen (Figure 38c).

Cnidae. Spirocysts, basitrichs, microbasic *p*-mastigophores, and microbasic amastigophores. Sizes and distribution of cnidae shown in Table 6, illustrated in Figure 39.

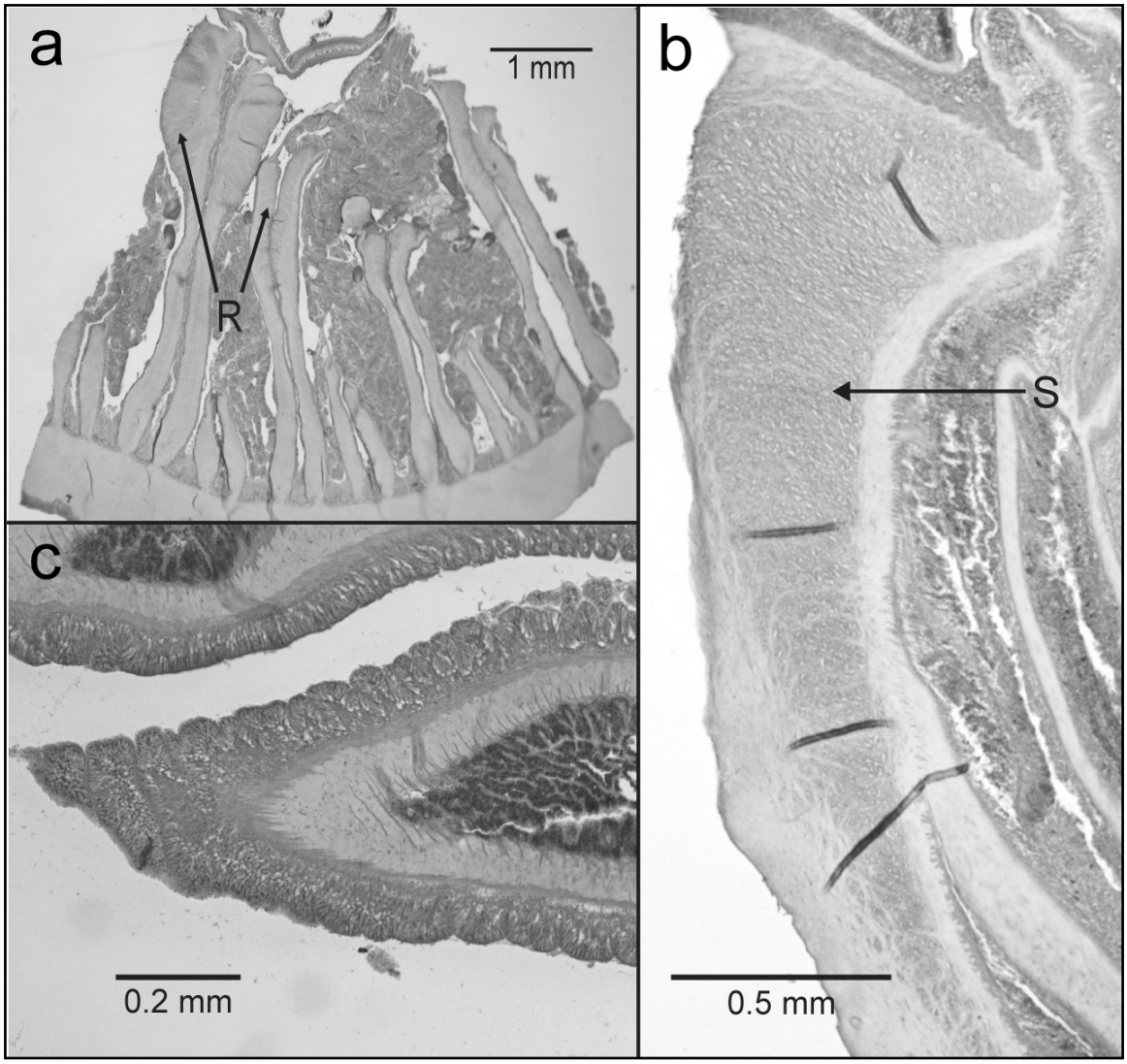

Figure 38. *Sagartiogeton californicus*. a. mesenteries with large diffuse retractor muscles (R); b. well developed mesogleal retractor muscle (S); c. Tentacle with ectodermal longitudinal musculature.

Discussion. The original description of *Actinothoë californica* Carlgren, 1940 lacks an illustration of the whole animal and many details of their anatomy. I was unable to locate type specimens to examine; however, the specimens that I did examine agree well with published details except that Carlgren (1940) did not find small basitrichs in all tissue types. These nematocysts were small and often sparse and easy to miss in specimens I

examined. Also, the microbasic amastigophores and basitrichs of the acontia that Carlgren (1940) measured were much smaller; however, size of microbasic amastigophores and basitrichs in the acontia of members of *Sagartiogeton*, the genus into which Carlgren (1949) placed the species, vary greatly from specimen to specimen (Carlgren 1942). Due to similarities in location, depth, and morphology, I have identified as *Sagartiogeton californicus* the specimens that I examined from the northeastern Pacific from Mexico to British Columbia that occur within MW and intermediate water from depths of 73 m [40 fm] to at least 1,463 m [800 fm] (Figure 40).The external anatomy of this species appears to be highly variable; however, nematocysts and internal anatomy of specimens throughout this gradient are consistent.

One specimen (USNM 53337) that had been identified by Charles Cutress as *Sagartiogeton californicus* differed from the specimens I examined in having a very long, lumpy scapulus with deep longitudinal furrows. It was larger (24 mm long, pedal disc 44 wide), and the older mesenteries were less muscular and more lobed, than observed in specimens I examined as well as the specimens Carlgren (1940) described. The specimen lacked small basitrichs in the tentacles and possessed two sizes of microbasic amastigophores in the acontia, the smallest approximately 27 μm long. I determined that this specimen is a member of family Sagartiidae, but is not a member of *Sagartiogeton californicus* as it does not match the description of the species by Carlgren (1940).

Specimens Examined. See Appendix 17.

Tissue and Cnida Type	Length x Width (µm)	n	N
Tentacles			
Gracile spirocysts (a)	14.7-37.4 (39.8) x 2.0-4.5 (4.9)	45	3/3
Robust spirocysts (b)	(16.6) 17.8-36.9 x 4.2-7.5 (8.8)	40	3/3
Microbasic amastigophores (c)	17.9-31.5 x 3.1-5.0	38	3/3
Basitrichs (d)	8.9-13.9 (17.3) x 1.5-2.3	41	3/3
Basitrichs (e)	17.0-29.3 x 2.2-3.2 (3.5)	38	3/3
Acontia			
Microbasic amastigophores (f)	55.1-70.1 x (5.2) 5.5-7.1 (7.5)	40	4/4
Basitrichs* (g)	11.2-17.3 x 1.7-2.3	23	4/4
Basitrichs (h)	35.8-44.3 x 2.9-4.1	40	4/4
Actinopharynx			
Microbasic amastigophores (i)	23.9-35.2 x 3.4-5.0	41	3/3
Basitrichs* (j)	10.5-15.0 x 1.4-2.1	16	3/3
Basitrichs (k)	25.0-34.0 x 2.8-3.2	28	3/3
Mesenterial Filaments			
Microbasic *p*-mastigophores? (l)	9.6-14.7 (16.9) x 3.0-4.9	30	3/4
Hoplotelic macrobasic *p*-mastigophores (m)	(35.3) 41.4-61.2 (66.1) x 6.2-9.0	10	1/4
Microbasic amastigophores (n)	(17.2) 18.7-33.0 (34.9) x(3.0) 3.4-5.2 (5.9)	48	4/4
Basitrichs* (o)	9.3-14.8 (15.5) x 1.5-2.3	34	4/4

Table 6. Cnida size and distribution of *Sagartiogeton californicus*. Because cnidae were measured from preserved specimens, the distinction between *p*-mastigophores and amastigophores is uncertain. * Sparse.

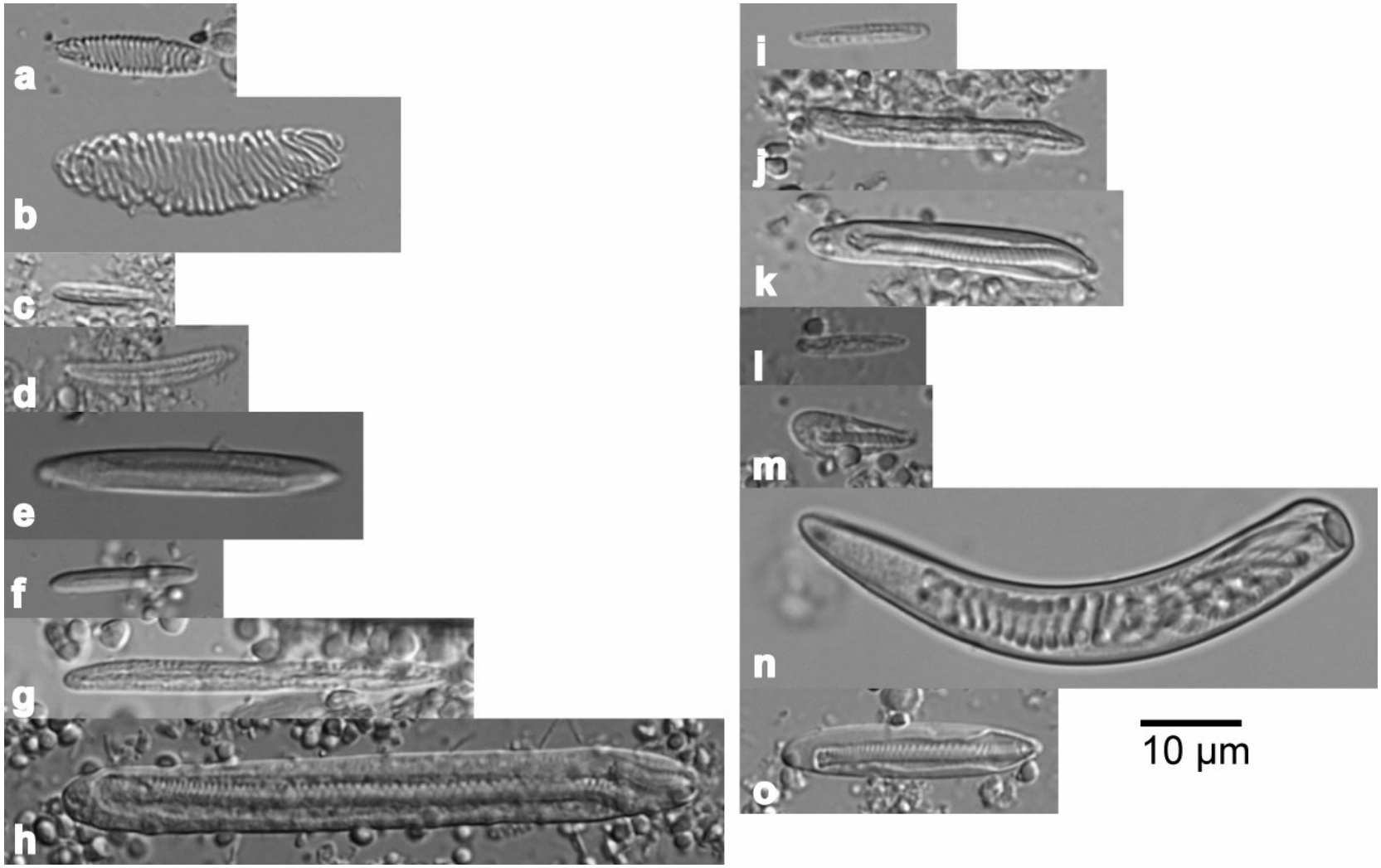

Figure 39. Cnidae of *Sagartiogeton californicus*. Correspond to letters in Table 6.

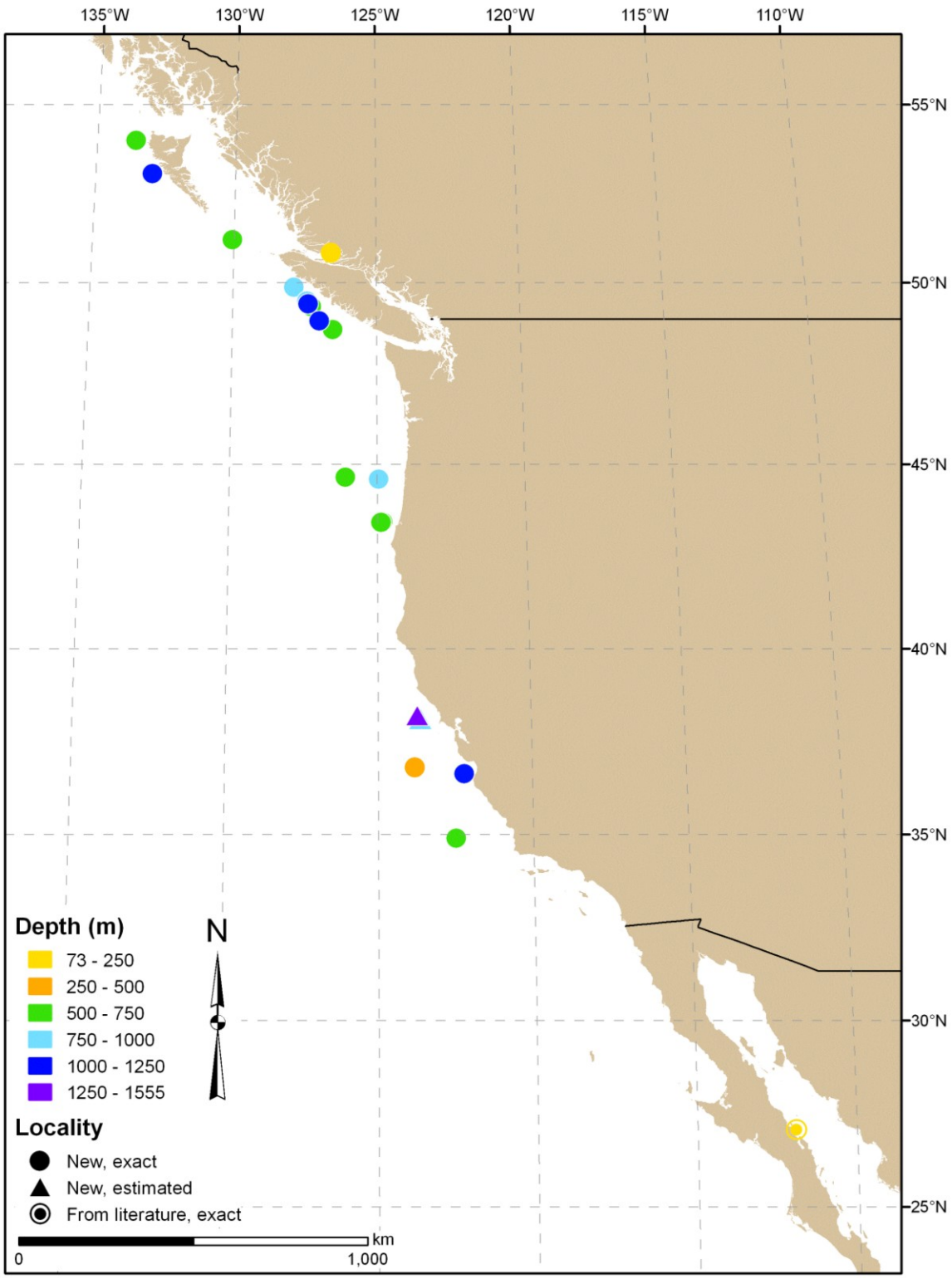

Figure 40. Distribution of *Sagartiogeton californicus* from Mexico to British Columbia.

Discussion

With the data available for the distribution of the 14 species, I have determined that 10 (71%) of the species studied appear to be endemic to the North Pacific, whereas only one genus (*Paraphelliactis*) and none of the families are endemic to the North Pacific Ocean. This follows the pattern found by Vinogradova (1959) for deep-sea invertebrates and Rodríguez *et al.* (2007) for sea anemones of the Southern Ocean: at the species level animals tend to be endemic to only one ocean, and at the generic and family levels they are widespread.

Of the 13 genera known to science from the northeastern Pacific Ocean, the Southern Ocean has 8 (62%) and the Atlantic Ocean has 12 (92%) in common. All the families from the northeastern Pacific Ocean are found in the Southern and Atlantic Oceans as well. The anemones of the deep northeastern Pacific Ocean, at the species, generic, and family level, do not appear to be more closely related to the anemone fauna of either the Southern Ocean or Atlantic Ocean. The anemone fauna of the North Pacific Ocean is highly endemic at the species level, but at the generic and family level it appears to have strong ties to the deep-sea fauna throughout the world.

The Depth Effect. Seven (50%) of the species I identified have been found only in the northeastern Pacific. Of the remaining seven species, only one appears to be truly cosmopolitan (*Actinauge verrillii*), two are also known from the Southern Ocean and likely span the southeastern Pacific as well (*Bathyphellia australis* and *Actinoscyphia groendyki* n. sp.), one is known from the Atlantic Ocean (*Monactis vestita*), and three are also known from the northwestern Pacific (*Liponema brevicorne*, *Metridium farcimen*,

and *Paractinostola faeculenta*). None of the species are known from the Indian Ocean; however, knowledge of the diversity of deep-sea anemones in the Indian Ocean is lacking, like that of the Pacific, and some of the North Pacific species may be found in the Indian Ocean.

Species that have the widest distribution occur in the deepest water. Five of the seven species that are found outside of the northeastern Pacific can occur in the CDW of the abyssal zone (*Actinauge verrillii* to 4,250 m, *Actinoscyphia groendyki* n. sp. to at least 3,819 m, *Bathyphellia australis* to 4,575 m, *Monactis vestita* to 5,320 m, and *Liponema brevicorne* to 4,134 m). *Paractinostola faeculenta*, which has been collected off Japan, occurs to 2,265 m, and *Metridium farcimen*, which has been collected off Russia, occurs to 2,740 m; both can occur in NPDW (a continuation of CDW).

In contrast to the seven widespread species, species that occupy mostly intermediate water of the bathyal zone (*Corallimorphus pilatus* from 250 to 2,026 m [1108 fm], and *Sagartiogeton californicus* from 73 to at least 1,463 m [800 fm]) appear to be endemic to the northeastern Pacific. Several species that occur within the CDW and/or NPDW of the abyssal zone (*Corallimorphus denhartogi* to 4,292 m, *Anthosactis nomados* to 4,134 m, *Bolocera kensmithi* n. sp. to 4,100 m, *Paraphelliactis pabista* to 4,100 m, and *Sicyonis careyi* n. sp. to 3,700 m) also appear to be endemic to the northeastern Pacific. In the case of *Anthosactis nomados,* its distribution is likely restricted by its symbiosis with the scaphopod *Fissidentalium actiniophorum,* which is only known from the northeastern Pacific (Shimek 1997, White *et al.* 1999).

Although deep-sea faunas tend to have strong links to other oceans, the pattern is most apparent in groups that are good dispersers; ostracods, isopods, and nematodes are

poor dispersers and therefore have poor gene flow, whereas foraminiferans have easily transferred larvae and therefore populations have good gene flow (Brandt *et al.* 2007). Future work on reproductive and dispersal strategies of the deep-sea anemones of the northeastern Pacific may help explain why some species that occupy the same depths are more widespread than others. The apparent restriction of some species to the northeastern Pacific may be due to the way they disperse.

Threat of the OMZ. Individuals of many of the deep sea species that I examined are likely to be affected by the expansion of the OMZ off the coast of Oregon. Animals that occupy intermediate and coastal waters may suffer from additional decreases in DO. Sea anemones, which have a high tolerance to hypoxia, will likely be one of the last groups of animals to die due to low oxygen conditions if the OMZ continues to strengthen and expand; once the oxygen concentrations have become so low as to kill the anemones, most other taxa within the OMZ will likely be dead.

Of the 14 species that I examined, at least nine (*Corallimorphus pilatus*, *Anthosactis nomados*, *Actinauge verrillii*, *Actinoscyphia groendyki* n. sp., *Liponema brevicorne*, *Metridium farcimen*, *Paractinostola faeculenta*, *Sagartiogeton californicus,* and *Sicyonis careyi* n. sp.) can be found within the same depth in the northeastern Pacific as the OMZ currently occupies (including near-surface waters to at least 1,200 m). The OMZ poses the biggest threat to the four species (*Corallimorphus pilatus, Anthosactis nomados*, *Sagartiogeton californicus,* and *Sicyonis careyi* n. sp.) that also appear to be endemic to the northeastern Pacific Ocean, and are of greatest concern because of their restricted ranges. This inventory of the anemones of the deep northeastern Pacific Ocean

can be compared to future inventories of anemones from within the OMZ to determine how the OMZs expansion has affected the anemone fauna.

Conclusion

I have described three new species of deep-sea anemone and expanded the distributions (latitude, longitude, and/or depth) of nine previously described species that occur in the northeastern Pacific Ocean. The seven species that occur outside of the northeastern Pacific Ocean all occur in the deep water of the abyssal zone (CDW and/or NPDW) that connects the world's oceans via the great ocean conveyor. Conversely, the two species that occur within only shallow and intermediate water of the bathyal zone appear to be restricted to the northeastern Pacific. The nine species that occupy shallow and intermediate waters in the northeastern Pacific occupy the benthos within the depth range of the OMZ off the coast of Oregon. Populations of those species will potentially be affected by reduced DO concentrations as the OMZ continues to strengthen and expand.

References

Arellano SM, Fautin DG. 2001. Redescription and range extension of the sea anemone *Exocoelactis actinostoloides* (Wassilieff, 1908), with revision of genus *Exocoelactis* (Cnidaria, Anthozoa, Actiniaria). 2001. Zoosystema 23(4):645-57.

Braby CE, Pearse VB, Bain BA, Vrijenhoek RC. 2009. Pycnogonid-cnidarian trophic interactions in the deep Monterey Submarine Canyon. Invert Biol 128(4):359-63.

Brandt A, Gooday AJ, Brandão SN, Brix S, Brökeland W, Cedhagen T, Choudhury M, Cornelius N, Danis B, De Mesel I, *et al.* 2007. First insights into the biodiversity and biogeography of the Southern Ocean deep sea. Nature 447:307-11.

Brandt JF. 1835. Prodromus Descriptionis Animalium AB H. Mertensio in Orbis Terrarum Circumnavigatione Observatorum. Vol. 1. Petropoli: Sumptibus Academiae 75 p.

Broecker WS. 1991. The great ocean conveyor. Oceanography 4(2):79-89.

Bruun AF. 1956. The abyssal fauna: its ecology, distribution and origin. Nature 177:1105-8.

Carlgren O. 1921. Actiniaria I. Danish Ingolf-Exped 5:1-241.

Carlgren O. 1933. The Godthaab Expedition 1928 Zoantharia and Actiniaria. Medd Grønland 79(8):1-55.

Carlgren O. 1934. Zur Revision der Actiniarien. Ark Zool 26A(18):1-36.

Carlgren, O. 1939. Actiniaria, Zoantharia, and Madreporaria. Zool Iceland 2(8):1-20.

Carlgren O. 1940. Eastern Pacific Expeditions of the New York Zoological Society XIX. Actiniaria from the Gulf of California. Zoologica 25(2):211-119.

Carlgren O. 1942. Actiniaria II. The Danish Ingolf-Exped 5(12):1-92.

Carlgren O. 1949. A survey of the Ptychodactiaria, Corallimorpharia, and Actiniaria. K Svenska Vetenskapsakad Handl 1(1):1-121.

Carlgren O. 1951. The actinian fauna of the Gulf of California. Proc US Natl Mus 101:415-49.

Carlgren O. 1956. Actiniaria from depths exceeding 6000 meters. Galathea Rep 2:9-16.

Carney RS, Carey AG. 1982. Distribution and diversity of holothuroids (Echinodermata) on Cascadia Basin and Tufts Abyssal Plain. Deep-Sea Res 29(5A):597-607.

Chan F, Barth JA, Lubchenco J, Kirincich A, Weeks H, Peterson WT, Menge BA. 2008. Emergence of anoxia in the California Current Large Marine Ecosystem. Science 319:920.

Deacon GER. 1982 Physical and biological zonation in the Southern Ocean. Deep-Sea Res 29(1):1-15.

Dunn DF. 1982. *Paraphelliactis pabista*, a new species of hormathiid sea anemone from abyssal northeastern Pacific waters (Coelenterata: Actiniaria). Syesis 15:51-56.

Dunn DF. 1983. Some Antarctic and sub-Antarctic sea anemones (Coelenterata: Ptychodactiaria and Actiniaria). Ant Res Ser 39:1-67.

Dunn DF, Bakus GL. 1977. Redescription and ecology of *Liponema brevicornis* (McMurrich, 1893), with definition of the family Liponematidae (Coelenterata, Actiniaria). Astarte 10:77-85.

Ekman S. 1953. Zoogeography of the Sea. London: Sidwick and Jackson Limited. 417 p.

Etter RJ, Rex MA, Chase MR, Quattro JM. 2005. Population differentiation decreases with depth in deep-sea bivalves. Evolution 59(7):1479-91.

Fautin DG. 1984. More Antarctic and Subantarctic sea anemones (Coelenterata: Corallimorpharia and Actiniaria). Ant Res Ser 41:1-42.

Fautin DG. 1997. Cnidarian reproduction: assumptions and their implications. In: den Hartog JC, editor. Proc 6th Intl Conf Coel Biol. Leiden: Nationaal Natuurhistorisch Museum p 151-62.

Fautin DG. 2009 Hexacorallians of the World. Available online at: http://geoportal.kgs.ku.edu/hexacoral/anemone2/index.cfm

Fautin DG, Bucklin A, Hand C. 1989. Systematics of sea anemones belonging to genus *Metridium* (Coelenterata: Actiniaria), with a description of *M. giganteum* new species. Wasmann J Biol 47(1-2):77-85.

Fautin DG, Daly M, Cappola V. 2005. Sea anemones (Cnidaria: Actiniaria) of the Faroe Islands: a preliminary list and biogeograhic context. Ann Soc Sci Faeroensis 41:77-87.

Fautin DG, Hand C. 2000. *Metridium farcimen*, the valid name of a common North Pacific sea anemone (Cnidaria: Actiniaria: Acontiaria). Proc Biol Soc Wash 113(4):1151-61.

Fautin DG, Hand C. 2007. Actiniaria. In: Carlton JT, editor. The Light and Smith Manual: Intertidal Invertebrates from Central California to Oregon. 4th ed. Los Angeles: University of California Press p 134-145.

Fautin DG, Hessler RR. 1989. *Marianactis bythios*, a new genus and species of actinostolid sea anemone (Coelenterata: Actiniaria) from the Mariana vents. Proc Biol Soc Wash 102(4):815-25.

Fautin DG, White TR, Pearson KE. 2002. Two new species of deep-water Corallimorpharia (Cnidaria: Anthozoa) from the northeast Pacific, *Corallimorphus denhartogi* and *C. pilatus*. Pac Sci 56(2):113-24.

Gage JD, Tyler PA. 1992. Deep-Sea Biology: A Natural History of Organisms at the Deep-Sea Floor. Cambridge (UK): Cambridge University Press. 524 p.

Gewin V. 2010. Dead in the water. Nature 466:812-814, doi:10.1038/466812a.

Gotshall D. 1994. Guide to Marine Invertebrates: Alaska to Baja California. Monterey: Sea Challengers. 112 pages.

Gravier C. 1918. Note préliminaire sur les Hexactiniaires recueillis au cours des croisières de la *Princesse-Alice* et de l'*Hirondelle* de 1888 à 1913 inclusivement. Bull Inst Oceanogr (Monaco) 346:1-24.

Hales B, Karp-Boss L, Perlin A, Wheeler PA. 2006. Oxygen production and carbon sequestration in an upwelling coastal margin. Global Biogeochem Cycles 20(3):GB3001:1-15, doi:10.1029.2005GB002517.

Humason, GL 1967. Animal Tissue Techniques. San Francisco: W.H. Freeman. 569 p.

Kamykowski D, Zentara SJ. 1990. Hypoxia in the world ocean as recorded in the historical data set. Deep-Sea Res 37(12):1861-74.

Keeling RF, Garcia HE. 2002. The change in oceanic O_2 inventory associated with recent global warming. Proc Natl Acad Sci 99(12):7848-53.

Kramer A, Francis L. 2004. Predation resistance and nematocyst scaling for *Metridium senile* and *M. farcimen*. Biol Bull 207:130-40.

Lomolino MV, Riddle BR, Brown JH. 2006. Biogeography. 3rd ed. Sunderland: Sinauer Associates, Inc. 845 p.

Mantyla AW, Reid JL. 1983. Abyssal characteristics of the World Ocean waters. Deep-Sea Res 30(8):805-33.

Matear RJ, Hirst AC. 2003. Long-term changes in dissolved oxygen concentrations in the ocean caused by protracted global warming. Global Biogeochem Cycles 17(4):1125, doi:10.1029/2002GB001997.

McCauley JE, Carey AG. 1967. Echinoidea of Oregon. J Fish Res Bd Canada 24(6):1385-401.

McMurrich JP. 1893. Report on the Actiniae collected by the United States Fish Commission Steamer Albatross during the winter of 1887-1888. Proc US Natl Mus 16(930):119-216.

Riemann-Zürneck, K. 1973. Actiniaria des Südwestatlantik. I. Hormathiidae. Helgol Wiss Meeres 25:273-325.

Riemann-Zürneck, K. 1986. On some abyssal sea anemones of the North Atlantic (Actiniaria: Hormathiidae). Mitt Hamb Zool Mus Inst 83:7-29.

Riemann-Zürneck K. 1991. A new species of *Sicyonis* (Actiniaria: Actinostolidae) from the abyssal NE Atlantic. Mitt Hamb Zool Mus Inst 88:7-15.

Riemann-Zürneck K. 1994. Taxonomy and ecological aspects of the Subarctic sea anemones *Hormathia digitata*, *Hormathia nodosa*, and *Allantactis parasitica* (Coelenterata, Actiniaria). Ophelia 39(3):197-224.

Riemann-Zürneck K. 1997. The deep-sea anemones *Bathyphellia margaritacea* and *Daontesia porcupina* sp. nov. with comments on the family Bathyphelliidae. J Mar Biol Assoc UK 77:361-74.

Rodríguez E, López-González PJ, Gili JM. 2007. Biogeography of Antarctic sea anemones (Anthozoa: Actiniaria): what do they tell us about the origin of the Antarctic benthic fauna? Deep-Sea Res II 54:1876-904.

Sanamyan NP, Sanamyan KE. 2007. Deep-water Actiniaria from East-Pacific hydrothermal vents and cold seeps. Invert Zool 4(1):83-102.

Segar DA. 1998. Introduction to Ocean Sciences. Belmont: Wadsworth Publishing Company. 497 p.

Shimek RL. 1997. A new species of eastern Pacific *Fissidentalium* (Mollusca: Scaphopoda) with a symbiotic sea anemone. Veliger 40(2):178-91.

Smith KL, Kaufmann RS, Baldwin RJ. 1994. Coupling of near-bottom pelagic and benthic processes at abyssal depths in the eastern North Pacific Ocean. Limnol Oceanogr 39(5):1101-18.

Swan CM, Siegel DA, Nelson NB, Craig AC, Nasir E. 2009. Biogeochemical and hydrographic controls on chromophoric dissolved organic matter distribution in the Pacific Ocean. Deep-Sea Res 56: 2175-92.

Tilesius GT. 1809. De nova actiniarum specie gigantea kamtschatica. Mem Acad Imp Sci St. Petersbourg 1:388-422.

Vaquer-Sunyer R, Duarte CM. 2008. Thresholds of hypoxia for marine biodiversity. Proc Natl Acad Sci 105(40):15452-7.

Verrill AE. 1922. The Actiniaria of the Canadian Arctic Expeditions, with notes on interesting species from Hudson Bay and other Canadian localities. Rep Can Arct Exped 1913-1918 8(G):89-164.

Vinogradova NG. 1959. The zoogeographical distribution of the deep-water bottom fauna in the abyssal zone of the ocean. Deep-Sea Res 5:205-8.

White TR, Wakefield Pagels AK, Fautin DG. 1999. Abyssal sea anemones (Cnidaria: Actiniaria) of the northeast Pacific symbiotic with molluscs: *Anthosactis nomados*, a new species, and *Monactis vestita* (Gravier, 1918). Proc Biol Soc of Wash 112(4):637-51.

Widersten B. 1976. Ceriantharia, Zoanthidea, Corallimorpharia, and Actiniaria from the continental shelf and slope off the eastern coast of the United States. Fish Bull 74(4):857-78.

Wyrtki K. 1962. The oxygen minima in relation to ocean circulation. Deep-Sea Res 9:11-23.

Zamponi MO, Acuña FH. 1992. Sobre las caracteristicas gonadales de *Monactis vestita* (Gravier, 1918), sensu Riemann-Zürneck, 1986 (Actiniaria, Hormathiidae). Iheringia 72:151-2.

Appendices

Appendix 1

Abbreviations of Repositories

CAS. California Academy of Sciences, San Francisco, California

CMN. Canadian Museum of Nature, Ottawa, Canada

KUBI. University of Kansas Biodiversity Institute, Lawrence, USA

LACM. Natural History Museum of Los Angeles County, Los Angeles, USA

MLML. Moss Landing Marine Laboratory, Moss Landing, USA

MZLU. Museum of Zoology, Lund University, Lund, Sweden

NEFSC. Northeast Fisheries Science Center, Woods Hole, USA

RBCM. Royal British Columbia Museum, Victoria, Canada

RMNH. Nationaal Natuurhistorisch Museum, Leiden, Netherlands

SBMNH. Santa Barbara Museum of Natural History, Santa Barbara, USA

SIO. Scripps Institution of Oceanography, La Jolla, USA

USNM. US National Museum of Natural History, Washington, USA

MOM. Musée Océanographique de Monaco, Monaco-Ville, Monaco

Appendix 2

Type Status Abbreviations

H = Holotype

S = Syntype(s)

P = Paratype(s)

Appendix 3

Sources of Locality Information

1 = Specimens examined in this study

2 = Fautin *et al.* 2002

3 = Fautin 1984

4 = White *et al.* 1999

5 = McMurrich 1893

6 = Dunn 1983

7 = Fautin 1997

8 = Widersten 1976

9 = Carlgren 1942

10 = Carlgren 1939

11 = Carlgren 1933

12 = Verrill 1992

13 = Fautin *et al.* 2005

14 = Gravier 1918

15 = Riemann-Zürneck 1986

16 = Dunn 1982

17 = Sanamyan and Sanamyan 2007

18 = Braby *et al.* 2009

19 = Dunn and Bakus 1977

20 = Fautin *et al.* 1989

21 = Tilesius 1809

22 = Brandt 1835

23 = Carlgren 1951

24 = Kramer and Francis 2004

25 = Carlgren 1940

Appendix 4.

Localities of *Corallimorphus denhartogi*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
31.40 to 31.47	-120.24 to -120.17	3880	--	Co 1388	SIO	P	1	2
34.07	-123.18	4100	Feb-1990	001391	KUIZ	H	1	1,2
34.63	-123.02	4100	22-Jul-1992	001607	KUIZ	--	2	1
34.64	-123.49	2975-3010	--	1000047	USNM	P	2	2
34.65	-123.97	4100	17-Jun-1994	001598	KUIZ	--	5	1
34.67	-123.05	4100	1-May-1995	001555	KUIZ	--	1	1
34.67	-123.18	4100	9-Jun-1995	001551	KUIZ	--	2	1
″	″	″	3-Jun-1995	001556	KUIZ	--	1	1
″	″	″	5-Jun-1996	001558	KUIZ	--	4	1
″	″	″	22-Sep-1994	001599	KUIZ	--	2	1
″	″	″	22-Jul-1991	001-00046-001	RBCM	P	1	1.2
34.68	-123.08	4100	5-Feb-1994	001606	KUIZ	--	3	1
34.68	-123.13	4100	30-Oct-1989	002166	KUIZ	--	4	1
34.70	-123.13	4100	7-Nov-1993	001549	KUIZ	--	2	1
34.70	-123.15	4100	14-Feb-1995	001554	KUIZ	--	5	1
″	″	″	″	146043	CAS	P	1	1,2
34.70	-123.23	4100	22-Oct-1994	001609	KUIZ	--	1	1
34.72	-123.12	4100	1-Aug-1991	001553	KUIZ	--	2	1
34.72	-123.18	4100	17-Feb-1996	001547	KUIZ	--	2	1
″	″	″	18-Feb-1990	001548	KUIZ	--	1	1
34.72	-123.23	4100	9-Oct-1996	001552	KUIZ	--	2	1
″	″	4134	12-Oct-1996	001600	KUIZ	--	2	1
34.73	-123.12	4100	22-Jul-1991	001601	KUIZ	--	3	1
34.73	-123.13	4100	24-Jun-1990	001602	KUIZ	--	1	1
34.75	-123.03	4100	24-Feb-1993	001608	KUIZ	--	1	1
34.75	-123.07	4100	21-Oct-1991	001550	KUIZ	--	7	1
34.75	-123.12	4100	24-Jun-1991	001605	KUIZ	--	1	1
34.77	-123.10	4100	20-Feb-1991	001603	KUIZ	--	1	1
34.77	-123.13	4100	17-Oct-1992	001604	KUIZ	--	4	1
34.78	-123.12	4134	--	24967	RMNH	P	1	2
″	″	″	12-Jun-1992	001557	KUIZ	--	5	1
36.27	-123.61	2820-2960	1-Mar-1992	001528	KUIZ	P	4	1,2

Localities of *Corallimorphus denhartogi* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
37.07	-123.41	3175-3180	29-Feb-1992	154362	CAS	P	1	1,2
37.37 to 37.27	-123.90 to -123.88	3592-3798	--	Co 2001	SIO	--	3	2
37.64	-123.47	2945-3075	--	C 0193	MLML	P	1	2
37.73	-123.12	4100	--	100903	USNM	P	1	2
40.37	-127.50	4250	--	144411	SBMNH	P	1	1,2
44.05	-125.40	2938	15-Jun-1972	211944	SBMNH	--	2	1
44.72	-127.38	3021	12-Jun-1974	144410	SBMNH	P	2	1,2
44.73	-124.50	4292	24-Jul-1967	211943	SBMNH	--	1	1
″	″	″	″	211946	SBMNH	--	1	1
44.76	-127.40	2790	22-Oct-1965	211945	SBMNH	--	1	1
--	--	3050-3056	12-Apr-2009	003298	KUIZ	--	2	1

Appendix 5.

Localities of *Corallimorphus pilatus*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
32.93 to 32.85	-117.62 to -117.60	896	--	Co 2009	SIO	P	2	2
36.76	-121.97	490	2-Apr-1998	001392	KUIZ	P	1	1,2
″	″	″	″	001393	KUIZ	P	1	1,2
45.88	-124.90	840	3-Apr-1967	144409	SBMNH	P	2	2
48.37 to 48.38	-126.46 to -126.47	1416-1433	29-Aug-2001	010-00168-001	RBCM	--	1	1
48.41	-126.10	274	--	69283	CAS	--	3	1
48.43 to 48.40	-126.14 to -126.14	315	23-Feb-1988	988-00258-008	RBCM	P	1	1,2
48.44	-126.34	1092	Feb-1972	69281	CAS	--	2	1
48.89	-126.91	900	--	001394	KUIZ	P	1	1,2
″	″	″	--	152514	CAS	P	1	1,2
″	″	″	--	100904	USNM	P	1	1
48.89 to 48.96	-126.91 to -126.90	900	28-Feb-1988	001-00044-001	RBCM	H	1	1,2
″	″	″	″	988-00268-034	RBCM	--	7	1,2
″	″	″	″	988-00268-042	RBCM	--	10	1
49.13	-127.00	513-525	30-Jul-1999	003-00010-003	RBCM	--	1	1
49.17 to 49.19	-127.07 to -127.09	526-569	5-Apr-2003	003256	KUIZ	--	2	1
55.55	-133.63	1921	Aug-1965	71091	CAS	--	7	1
55.71	-134.75	2026 [1108 fm]	4-Sep-1965	69292	CAS	--	2	1
ALASKA: Gulf of Alaska		340	26-Jul-2001	175088	CAS	--	3	1
CALIFORNIA: off Monterey Bay		1034-1107	18-Nov-1975	71108	CAS	--	1	1

Appendix 6.

Localities of *Bolocera kensmithi* n. sp.

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
34.67	-123.18	4100	22-Sep-1994	001512	KUIZ	2	1
″	″	″	3-Jun-1995	001518	KUIZ	1	1
″	″	″	5-Jun-1996	001956	KUIZ	4	1
″	″	″	12-Oct-1996	003326	KUIZ	2	1
34.68	-123.13	4100	30-Oct-1989	002169	KUIZ	1	1
34.68	-123.18	4100	10-Feb-1994	001509	KUIZ	1	1
34.70	-123.03	4100	14-Nov-1995	001520	KUIZ	1	1
34.70	-123.13	4100	7-Nov-1993	001507	KUIZ	1	1
34.70	-123.15	4100	1-May-1995	001515	KUIZ	2	1
34.72	-123.12	4100	1-Aug-1991	001496	KUIZ	3	1
34.72	-123.22	4100	29-Jan-1996	001522	KUIZ	1	1
34.75	-123.03	4100	24-Feb-1995	001504	KUIZ	2	1
34.75	-123.07	4100	21-Oct-1991	001498	KUIZ	1	1
34.77	-123.13	4100	17-Oct-1992	001503	KUIZ	1	1
34.78	-123.07	4100	26-Feb-1992	001501	KUIZ	1	1
49.35 to 49.33	-127.55 to -127.52	1804-1827	6-Apr-2003	003252	KUIZ	1	1
49.71 to 49.71	-127.95 to -127.96	2003-2091	15-Apr-2003	003285	KUIZ	1	1
50.02 to 50.03	-128.85 to -128.86	2025	7-Oct-2006	010-00186-002	RBCM	7	1

Appendix 7.

Localities of *Actinoscyphia groendyki* n. sp.

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
-77.55 to -77.52	-163.03 to -163.08	606-638	5-Feb-1968	28764	CAS	1	1,3
-60.03 to -59.92	-49.23 to -49.23	3819-3876	7-Mar-1963	28763	CAS	1	1,3
-59.98 to -59.97	-70.72 to -70.53	2782-2827	--	60677	USNM	1	3
-57.38	-26.57	2248-2402	26-May-1975	28765	CAS	2	1,3
-56.49	-26.78	2248-2387	30-May-1975	29628	CAS	1	1,3
-56.49	-28.02	2384-2402	--	60695	USNM	3	3
-56.07 to -56.00	-33.98 to -33.95	3138-3239	--	60674	USNM	3	3
-56.06	-26.97	2128-2161	3-Jun-1975	29627	CAS	1	1,3
-55.25 to -55.30	-58.92 to -58.97	3514-3642	5-Dec-1962	29629	CAS	3	1,3
-54.00 to -54.08	-33.67 to -33.72	2663-2718	--	60676	USNM	1	3
-53.22 to -53.27	-75.68 to -75.68	1500-1666	--	60675	USNM	1	3
43.27	-125.84	3000	27-Jul-1965	422588	SBMNH	19	1
43.72	-125.48	2997	17-Jun-1972	422618	SBMNH	13	1
43.73	-125.43	3000	17-Jun-1972	422612	SBMNH	9	1
43.74	-125.43	2992	16-Jun-1972	422610	SBMNH	12	1
44.05	-125.39	2938	15-Jun-1972	422567	SBMNH	85	1
″	″	″	″	422628	SBMNH	37	1
44.10	-125.38	2740	14-Jun-1972	422568	SBMNH	73	1
44.11	-125.41	2938	15-Jun-1972	422566	SBMNH	148	1
44.38	-125.58	2878	4-Aug-1974	422621	SBMNH	11	1
44.40	-125.59	2893	4-Aug-1974	83596	SBMNH	24	1
44.47	-125.54	2800	13-Jan-1965	422652	SBMNH	6	1
44.49	-126.48	2772	23-Oct-1965	422620	SBMNH	9	1
44.50	-125.40	2772	9-Apr-1965	422572	SBMNH	12	1
44.52	-125.59	2736	2-Oct-1965	69288	CAS	2	1
44.55	-126.95	2736	8-Feb-1965	69286	CAS	1	1
44.55	-128.32	2820	3-Nov-1973	422649	SBMNH	7	1
44.56	-124.93	2520	25-Jul-1967	211978	SBMNH	5	1
44.56	-125.57	2809	14-Oct-1966	211924	SBMNH	18	1
44.58	-125.57	2807	15-Jul-1968	422650	SBMNH	1	1
44.58	-125.66	2862	17-Jul-1968	422636	SBMNH	1	1
44.58	-128.36	2826	3-Nov-1973	422569	SBMNH	50	1

Localities of *Actinoscyphia groendyki* n. sp. (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
44.59	-125.59	1900	15-Jul-1968	211925	SBMNH	1	1
″	″	2816	16-Mar-1970	422576	SBMNH	43	1
44.61	-125.63	2772	17-Jun-1964	422602	SBMNH	2	1
44.61	-126.13	3000	30-Dec-1963	422643	SBMNH	7	1
44.61	-127.32	3030	12-Jun-1974	422642	SBMNH	40	1
44.63	-125.67	2816	15-Mar-1970	422608	SBMNH	13	1
″	″	2800	16-Mar-1970	211923	SBMNH	11	1
44.64	-126.62	2850	20-Feb-1971	422585	SBMNH	17	1
44.64	-126.92	2806	23-Oct-1965	422637	SBMNH	5	1
44.65	-125.50	2800	29-Mar-1969	422581	SBMNH	47	1
44.66	-126.08	2794	23-Oct-1965	422648	SBMNH	3	1
44.66	-125.57	2800	10-Jan-1967	422640	SBMNH	3	1
44.67	-125.68	2850	29-Dec-1964	422597	SBMNH	6	1
44.67	-128.19	2700	22-Oct-1965	422631	SBMNH	3	1
44.67	-128.43	2994	2-Nov-1973	422634	SBMNH	3	1
44.68	-125.59	2800	14-Jan-1968	69289	CAS	1	1
″	″	″	″	422629	SBMNH	25	1
44.68	-125.62	2800	26-Jul-1967	211922	SBMNH	20	1
44.69	-125.60	2779	6-Oct-1969	144413	SBMNH	39	1
44.71	-125.53	2825	6-Oct-1969	422570	SBMNH	114	1
44.72	-127.38	3021	12-Jun-1974	422592	SBMNH	16	1
44.73	-124.50	2510	31-Oct-1967	211926	SBMNH	11	1
44.73	-127.46	2803	2-Feb-1973	422589	SBMNH	29	1
44.74	-125.62	2830	28-Mar-1969	422591	SBMNH	11	1
44.74	-127.43	2749	2-Feb-1973	422614	SBMNH	18	1
44.74	-127.48	2818	3-Feb-1973	422625	SBMNH	23	1
44.75	-125.99	2800	1-Dec-1965	69290	CAS	5	1
44.75	-126.50	2787	19-Jan-1970	422578	SBMNH	19	1
44.76	-127.40	2790	22-Oct-1965	422594	SBMNH	6	1
44.82	-125.66	2810	29-Oct-1967	144408	SBMNH	11	1
″	″	″	″	422633	SBMNH	14	1
44.83	-125.58	2743	8-Mar-1972	422586	SBMNH	12	1
44.89	-126.51	2770	18-Jan-1970	422590	SBMNH	8	1
″	″	″	″	422600	SBMNH	4	1

Localities of *Actinoscyphia groendyki* n. sp. (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
44.89	-126.51	2770	18-Jan-1970	423132	SBMNH	8	1
44.91	-126.58	2774	19-Jan-1970	422638	SBMNH	12	1
44.92	-127.47	2838	4-Nov-1973	422619	SBMNH	23	1
44.96	-126.62	2770	19-Feb-1971	422617	SBMNH	16	1
44.97	-125.74	2790	19-Mar-1970	422632	SBMNH	12	1
44.97	-126.60	2795	18-Feb-1971	422646	SBMNH	14	1
44.99	-126.66	2770	19-Feb-1971	422635	SBMNH	8	1
45.00	-127.49	2884	5-Nov-1973	422575	SBMNH	33	1
45.03	-127.52	2850	5-Nov-1973	422574	SBMNH	38	1
45.04	-127.54	2838	5-Nov-1973	422626	SBMNH	28	1
45.15	-125.64	2669	15-Jul-1969	422601	SBMNH	1	1
45.20	-127.54	2809	14-Mar-1973	422579	SBMNH	26	1
45.28	-126.65	2721	18-Jan-1970	422644	SBMNH	19	1
45.29	-126.47	2710	18-Feb-1971	144417	SBMNH	20	1
45.30	-125.67	2633	5-Oct-1969	422605	SBMNH	1	1
45.30	-125.79	2605	18-Mar-1970	422604	SBMNH	1	1
45.34	-126.60	2750	17-Feb-1971	422624	SBMNH	13	1
45.36	-127.55	2800	18-May-1971	422622	SBMNH	27	1
45.38	-127.61	2798	18-May-1971	422641	SBMNH	7	1
45.40	-127.65	2811	18-May-1971	422607	SBMNH	23	1
45.45	-127.48	2743	3-Feb-1973	422577	SBMNH	30	1
45.53	-127.47	2780	3-Feb-1973	422615	SBMNH	15	1
45.64	-126.69	2670	16-Feb-1971	422623	SBMNH	11	1
45.64	-126.80	2721	17-Feb-1971	422616	SBMNH	12	1
45.65	-125.81	2425	19-Mar-1970	422593	SBMNH	1	1
45.73	-125.45	2225	14-Jul-1969	422606	SBMNH	1	1
45.77	-126.72	2675	16-Jan-1970	422630	SBMNH	1	1
45.78	-126.59	2665	15-Feb-1971	422645	SBMNH	17	1
45.84	-126.48	2651	17-Jan-1970	422611	SBMNH	24	1
45.88	-126.65	2666	16-Jan-1970	422598	SBMNH	7	1
45.92	-127.58	2765	17-May-1971	422573	SBMNH	26	1
45.93	-126.60	2670	15-Feb-1971	422599	SBMNH	3	1
45.94	-125.70	2195	30-Mar-1969	422595	SBMNH	1	1
45.94	-127.61	2761	17-May-1971	422613	SBMNH	13	1

Localities of *Actinoscyphia groendyki* n. sp. (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
45.94	-127.64	2763	13-Mar-1973	422571	SBMNH	21	1
45.95	-127.55	2763	11-Mar-1973	422582	SBMNH	32	1
45.96	-126.63	2743	14-Feb-1971	422627	SBMNH	30	1
46.03	-127.53	2740	12-Mar-1973	422580	SBMNH	27	1
46.04	-126.56	2706	15-Feb-1971	422596	SBMNH	1	1
46.08	-125.58	2156	3-Oct-1969	422603	SBMNH	2	1
52.08 to 52.09	-131.53 to -131.52	4292	5-Aug-2004	010-00216-004	RBCM	2	1
52.77	-132.61	1330	14-Oct-2006	010-00192-001	RBCM	1	1
53.06	-132.98	1225-1240	21-Mar-1991	991-00332-058	RBCM	6	1
CALIFORNIA: San Clemente Basin		1880-1845	14-Jan-1985	95889	CAS	1	1
OREGON		2850	30-Apr-1996	110755	CAS	1	1
OREGON		2808	21-Nov-1964	160270	CAS	5	1
OREGON		2853	21-Aug-1965	69287	CAS	1	1
OREGON: OSU offshore station: OTB 112		2810	Mar-1966	422647	SBMNH	5	1
OREGON: OSU offshore station: OTB 77		2926	29-Jul-1965	422639	SBMNH	1	1
ALASKA: Aleutian Islands		1039	30-Jun-2004	180914	CAS	2	1

Appendix 8.

Localities of *Anthosactis nomados*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
34.65	-122.97	4100	17-Jun-1994	001026	KUIZ	--	6	1
34.67	-123.05	4100	1-May-1995	001030	KUIZ	--	4	1
34.67	-123.13	4100	12-Oct-1996	001559	KUIZ	--	2	1
″	″	″	9-Oct-1996	001561	KUIZ	--	4	1
″	″	″	″	001562	KUIZ	--	2	1
34.67	-123.18	4100	22-Sep-1994	001027	KUIZ	--	7	1
″	″	″	--	001031	KUIZ	--	9	1
″	″	″	9-Jun-1995	001032	KUIZ	--	3	1
″	″	″	5-Jun-1996	001564	KUIZ	--	9	1
″	″	″	31-May-1996	001565	KUIZ	--	15	1
34.68	-123.18	4000	4-Feb-1994	96574	USNM	P	1	4
34.70	-123.13	4100	7-Nov-1993	001019	KUIZ	H	1	1,4
34.70	-123.23	4100	22-Oct-1994	001028	KUIZ	--	11	1
34.72	-123.10	4100	19-Jul-1993	996-00024-001	RBCM	P	1	1,4
″	″	″	1-May-1995	996-00025-001	RBCM	P	1	1,4
34.72	-123.23	4100	12-Oct-1996	001563	KUIZ	--	5	1
34.75	-123.03	4100	24-Feb-1993	143214	SBMNH	P	1	4
34.75	-123.07	4100	21-Oct-1994	001023	KUIZ	--	1	1
34.77	-123.13	4100	17-Oct-1992	106264	CAS	P	1	1,4
″	″	″	″	92-113.1	LACM	P	1	4
34.82 to 34.85	-123.21 to -123.25	4080	--	002172	KUIZ	--	2	1
39.55	-127.30	4325	6-Jan-1983	422793	SBMNH	--	1	1
43.43	-124.80	530	3-Jul-1974	422832	SBMNH	--	3	1
43.44	-124.83	570	3-Apr-1974	422831	SBMNH	--	7	1
43.47	-124.85	530	4-Jun-1974	422830	SBMNH	--	3	1
44.10	-125.38	2740	14-Jun-1972	422834	SBMNH	--	10	1
44.59	-125.59	2816	16-Mar-1970	422833	SBMNH	--	40	1
44.97	-132.24	3500	7-Oct-1972	422791	SBMNH	--	20	1
45.02	-135.23	3932	--	345407	SBMNH	--	5	4
45.03	-135.39	3990	--	345408	SBMNH	--	1	4
45.03	-134.70	3700	--	345405	SBMNH	--	45	4
45.06	-134.75	3700	--	345406	SBMNH	--	5	4

Localities of *Anthosactis nomados* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
45.09	-133.18	3700	--	345404	SBMNH	--	43	4
CALIFORNIA: ~34.7°, -123.0°		4100	--	001020	KUIZ	--	1	1
CALIFORNIA: ~34.7°, -123.0°		4100	--	001021	KUIZ	--	1	1
CALIFORNIA: ~34.7°, -123.0°		4100	--	001022	KUIZ	--	1	1
CALIFORNIA: ~34.7°, -123.0°		4100	--	001024	KUIZ	--	18	1
CALIFORNIA: ~34.7°, -123.0°		4100	--	001025	KUIZ	--	2	1
CALIFORNIA: ~34.7°, -123.0°		4100	--	001029	KUIZ	--	3	1

Appendix 9.

Localities of *Paractinostola faeculenta*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
32.79	-119.51	1400	7-Jul-1989	68113	CAS	--	1	1
33.13	-118.67	757 [414 fm]	--	17803	USNM	S	6	5
33.42	-118.25	457 [250 fm]	1-Jul-1949	422468	SBMNH	--	1	1
34.03	-119.52	201 [110 fm]	Mar-1967	45569	SBMNH	--	1	1
34.08	137.98	1211 [662 fm]	20-Oct-1906	96580	CAS	--	1	1
34.47	-120.22	82 [45 fm]	Sep-1967	45593	SBMNH	--	1	1
34.49 to 34.51	-121.20 to -121.19	443	26-Oct-1997	001439	KUIZ	--	2	1
34.56 to 34.57	-122.98 to -122.96	797	25-Oct-1997	001440	KUIZ	--	3	1
34.89 to 34.91	-122.50 to -122.49	687	26-Oct-1997	001450	KUIZ	--	8	1
34.98 to 35.00	-122.55 to -122.54	481	26-Oct-1997	001447	KUIZ	--	6	1
35.01 to 35.03	-122.58 to -122.57	424	26-Oct-1997	001443	KUIZ	--	1	1
35.43 to 35.45	-122.65 to -122.65	562	27-Oct-1997	001453	KUIZ	--	9	1
35.45 to 35.46	-122.37 to -122.35	1050	27-Oct-1997	001459	KUIZ	--	2	1
36.35 to 36.37	-123.82 to -123.82	817	29-Oct-1997	001465	KUIZ	--	10	1
36.70	-122.21	1034-1107	18-Nov-1975	21942	CAS	--	2	1
36.72 to 36.70	-122.22 to -122.18	992-1024	8-Apr-2009	003297	KUIZ	--	2	1
″	″	″	″	003302	KUIZ	--	14	1
36.75 to 36.77	-122.46 to -122.48	2075-2250	10-Apr-2009	003301	KUIZ	--	5	1
43.33	-125.17	1600	4-Apr-1973	422451	SBMNH	--	3	1
″	″	1000	″	422456	SBMNH	--	2	1
43.38	-124.70	400	2-Apr-1973	422458	SBMNH	--	1	1
43.39	-125.31	2000	4-Apr-1973	211927	SBMNH	--	4	1
43.43	-124.86	665	6-Jul-1974	422460	SBMNH	--	1	1
43.44	-124.81	530	26-Mar-1975	422444	SBMNH	--	2	1
43.49	-124.82	550	4-Jun-1974	422441	SBMNH	--	1	1
″	″	1200	15-Jan-1965	422443	SBMNH	--	4	1
44.36	-125.13	933-1097	19-Oct-1991	422453	SBMNH	--	2	1
44.40	-125.07	1000	21-Jun-1962	422463	SBMNH	--	4	1
44.40	-125.24	2000	14-Aug-1961	211928	SBMNH	--	2	1
44.46	-125.24	1100		422461	SBMNH	--	1	1
44.58	-124.93	800	17-Jun-1964	422449	SBMNH	--	1	1
44.58	-125.04	1250	11-Apr-1965	422445	SBMNH	--	3	1

Localities of *Paractinostola faeculenta* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
44.59	-124.97	1000	15-Mar-1970	211929	SBMNH	--	1	1
44.60	-124.95	800	16-Jan-1968	422448	SBMNH	--	4	1
44.61	-124.94	800	10-Apr-1965	422467	SBMNH	--	1	1
44.63	-124.59	400	16-Jun-1963	422442	SBMNH	--	2	1
44.64	-124.89	600	16-Jun-1963	422454	SBMNH	--	2	1
44.65	-124.61	200	19-Feb-1964	422457	SBMNH	--	2	1
44.65	-125.15	1170	2-Oct-1970	422465	SBMNH	--	1	1
44.70	-124.97	800	14-Jan-1965	422462	SBMNH	--	2	1
45.38	-125.06	1200	4-Apr-1973	422480	SBMNH	--	4	1
45.82	-125.67	2195	4-Oct-1969	422464	SBMNH	--	1	1
45.83	-124.72	400	24-Mar-1966	422447	SBMNH	--	1	1
45.91	-124.92	800	25-Oct-1967	422469	SBMNH	--	6	1
45.96	-125.77	2265	20-Mar-1970	422450	SBMNH	--	1	1
48.17	-126.06	930-1000	7-Feb-1990	990-00327-002	RBCM	--	9	1
″	″	″	″	990-00327-032	RBCM	--	1	1
48.37 to 48.38	-126.46 to -126.47	1416-1433	29-Aug-2001	010-00168-002	RBCM	--	1	1
48.42	-126.39	1100	6-Feb-1990	990-00325-010	RBCM	--	5	1
″	″	″	″	990-00325-030	RBCM	--	1	1
48.64 to 48.64	-126.38 to -126.00	769-786	30-Aug-2001	010-00169-001	RBCM	--	2	1
48.70 to 48.67	-126.54 to -126.57	1167-1181	21-Oct-2005	010-00184-001	RBCM	--	4	1
48.72	-126.51	550	25-Feb-1988	988-00261-013	RBCM	--	1	1
48.74	-126.50	461	8-Sep-1964	38004	CAS	--	4	1
48.95 to 48.96	-126.97 to -126.98	1054-1075	17-Apr-2003	003287	KUIZ	--	3	1
49.00 to 49.02	-126.92 to -126.94	693-719	5-Apr-2003	010-00175-002	RBCM	--	1	1
49.22	-127.12	400-500	28-Feb-1988	988-00267-011	RBCM	--	1	1
49.42	-127.37	1000-1166	3-Feb-1990	990-00320-009	RBCM	--	3	1
49.51	-123.28	245	19-Dec-1978	979-11062-001	RBCM	--	2	1
″	″	262	8-Mar-1982	982-00052-002	RBCM	--	1	1
49.52	-123.28	270	14-Feb-1977	977-00016-004	RBCM	--	2	1
49.71 to 49.71	-127.95 to -127.96	2003-2091	15-Apr-2003	003284	KUIZ	--	2	1
″	″	″	″	010-00177-001	RBCM	--	2	1
49.72	-128.47	2195 [1200 fm]	9-Sep-1964	38007	CAS	--	3	1
″	″	″	″	183886	CAS	--	1	1
49.80	-123.98	602	4-Dec-1982	69657	CAS	--	1	1

Localities of *Paractinostola faeculenta* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
50.16 to 50.15	-128.73 to -128.75	1889-1910	12-Apr-2003	003258	KUIZ	--	1	1
50.90	-130.05	2195 [1200 fm]	11-Sep-1964	38005	CAS	--	4	1
51.72	-131.23	1829 [1000 fm]	5-Aug-1965	38006	CAS	--	3	1
″	″	″	″	69718	CAS	--	1	1
53.06	-132.98	1225-1240	21-Mar-1991	991-00332-056	RBCM	--	2	1
53.55	-133.63	1921	1-Aug-1965	60080	CAS	--	1	1
53.99 to 54.01	-133.61 to -133.62	490-580	3-Sep-2002	010-00173-004	RBCM	--	1	1
54.08 to 54.07	-134.12 to -134.16	1722-2083	2-Sep-2002	003266	KUIZ	--	1	1
CALIFORNIA: Bodega Bay: Sonoma County: NNW of Bodega Head		--	16-Mar-1965	21938	CAS	--	1	1
CALIFORNIA: Bodega Bay: Sonoma County: NNW of Bodega Head		549-567 [300-310 fm]	16-Mar-1965	21936	CAS	--	1	1
CALIFORNIA: British Columbia: Strait of Georgia: entrance to Howe Sound		274-366 [150-200 fm]	Dec-1963	21943	CAS	--	2	1
CALIFORNIA: British Columbia: Vancouver Island: 32 mi. Southwest of Sydney Inlet		282 [154 fm]	26-May-1972	21941	CAS	--	1	1
CALIFORNIA: British Columbia: Vancouver Island: Straits of Georgia: off Winchelsea Islands		426-439 [233-240 fm]	4-Dec-1963	21940	CAS	--	6	1
CALIFORNIA: Gulf of Farallones		913-1000	16-Dec-1985	69298	CAS	--	12	1
CALIFORNIA: Gulf of Farallones		500	13-Dec-1985	110760	CAS	--	1	1
CALIFORNIA: Humboldt County: north of Trinidad		--	Jan-1968	95143	CAS	--	1	1
CALIFORNIA: Monterey Bay: Monterey Canyon		1199-1409	16-Nov-1975	110754	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		400	9-May-1985	67936	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		1200-1250	6-Feb-1985	96698	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		990-995	6-Feb-1985	96719	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		1200	11-May-1984	183912	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		1000	1-Nov-1989	65166	CAS	--	2	1
CALIFORNIA: off San Mateo County: west of Pigeon Point: south of SE Farallon Island		183-366 [100-200 fm]	29-Dec-1971	4088	CAS	--	2	1
CALIFORNIA: Sonoma County: 24 mi. W by S of Bodega Bay: south side of Bodega Canyon		494-585 [270-320 fm]	Feb-1965	21939	CAS	--	1	1
OREGON		530-603	7-Mar-1974	161245	CAS	--	3	1
OREGON		700	4-Jul-1974	422455	SBMNH	--	1	1

Localities of *Paractinostola faeculenta* (continued)

Locality	Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
OREGON	2225	--	422452	SBMNH	--	2	1
OREGON	800	--	422459	SBMNH	--	1	1
OREGON	1250	15-Jan-1965	422446	SBMNH	--	4	1
OREGON	1000	--	422466	SBMNH	--	1	1
ALASKA: Gulf of Alaska	533	22-Jun-1999	173041	CAS	--	1	1
ALASKA: Gulf of Alaska	462	9-Jun-2001	175120	CAS	--	3	1

Appendix 10.

Localities of *Sicyonis careyi* n. sp.

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
43.72	-125.48	2997	17-Jun-1972	422539	SBMNH	2	1
43.74	-125.43	2992	19-Jun-1972	422533	SBMNH	3	1
44.04	-125.09	2825	6-Oct-1969	422508	SBMNH	11	1
44.05	-125.39	2938	15-Jun-1972	422565	SBMNH	6	1
44.07	-125.40	2992	15-Jun-1972	422561	SBMNH	3	1
44.10	-125.38	2940	14-Jun-1972	211935	SBMNH	1	1
″	″	2740	14-Jun-1972	422551	SBMNH	3	1
44.11	-125.41	2938	15-Jul-1972	211932	SBMNH	4	1
44.38	-125.58	2878	4-Aug-1974	422550	SBMNH	5	1
44.40	-125.59	2893	4-Aug-1974	83595	SBMNH	7	1
44.50	-125.40	2772	9-Apr-1965	422518	SBMNH	7	1
44.55	-126.95	2736	8-Feb-1965	422544	SBMNH	1	1
44.56	-125.57	2809	14-Oct-1966	422517	SBMNH	5	1
44.58	-125.66	2862	17-Jul-1969	422547	SBMNH	3	1
44.58	-128.36	2826	3-Nov-1973	422534	SBMNH	1	1
44.59	-125.57	2853	15-Oct-1966	422510	SBMNH	13	1
44.59	-125.59	2807	15-Jul-1968	211930	SBMNH	7	1
″	″	2816	16-Mar-1970	422509	SBMNH	13	1
44.61	-125.63	2772	10-Aug-1964	422560	SBMNH	3	1
44.61	-126.13	2850	29-Dec-1963	422545	SBMNH	2	1
44.63	-125.67	2916	16-Mar-1970	422512	SBMNH	13	1
44.64	-126.62	2850	19-Feb-1971	422524	SBMNH	1	1
44.64	-126.92	2806	23-Oct-1965	211940	SBMNH	1	1
44.65	-125.50	2800	29-Mar-1969	422537	SBMNH	10	1
44.65	-125.61	2800	19-May-1964	211939	SBMNH	2	1
44.65	-126.67	2832	20-Feb-1971	422522	SBMNH	1	1
44.67	-125.68	2850	29-Dec-1963	422562	SBMNH	1	1
44.67	-126.35	2856	20-May-1964	422557	SBMNH	4	1
44.67	-126.78	2832	20-Feb-1971	422536	SBMNH	2	1
44.69	-125.60	2779	6-Oct-1969	422511	SBMNH	22	1
44.70	-125.62	2800	19-Feb-1964	422540	SBMNH	1	1
″	″	″	″	422542	SBMNH	1	1

Localities of *Sicyonis careyi* n. sp. (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
44.72	-128.38	2780	2-Feb-1973	422548	SBMNH	1	1
44.73	-127.46	2803	11-Dec-1972	422521	SBMNH	1	1
44.73	-124.50	2510	31-Oct-1967	211942	SBMNH	15	1
44.74	-125.62	2830	28-Mar-1969	422515	SBMNH	5	1
44.74	-127.43	2749	2-Feb-1973	422558	SBMNH	1	1
44.74	-127.48	2818	3-Feb-1973	422563	SBMNH	6	1
44.75	-125.61	2800	25-Jul-1967	211934	SBMNH	2	1
44.76	-127.40	2790	22-Oct-1965	422549	SBMNH	2	1
44.82	-125.66	2810	29-Oct-1967	422532	SBMNH	3	1
44.83	-125.58	2743	8-Mar-1972	422529	SBMNH	11	1
44.92	-125.58	2706	19-Jul-1969	422543	SBMNH	8	1
44.94	-125.66	2760	17-Mar-1970	422530	SBMNH	7	1
44.96	-126.62	2770	19-Feb-1971	422535	SBMNH	3	1
44.97	-125.74	2790	17-Mar-1970	422531	SBMNH	7	1
44.97	-126.60	2795	18-Feb-1971	422523	SBMNH	1	1
44.97	-132.25	3585	6-Oct-1972	211933	SBMNH	2	1
44.98	-125.74	600	7-Jun-1974	211938	SBMNH	1	1
″	″	2790	17-Mar-1970	211937	SBMNH	1	1
44.98	-132.20	3585	25-Oct-1972	211941	SBMNH	2	1
45.00	-127.49	2884	11-May-1973	422528	SBMNH	1	1
45.10	-133.18	3700	8-Oct-1972	211936	SBMNH	1	1
45.20	-127.54	2809	14-Mar-1973	422527	SBMNH	1	1
45.31	-126.53	2750	18-Feb-1971	422541	SBMNH	4	1
45.34	-126.60	2750	17-Feb-1971	422559	SBMNH	3	1
45.35	-125.62	2500	4-Oct-1960	422516	SBMNH	4	1
45.40	-127.65	2811	17-May-1970	422525	SBMNH	1	1
45.45	-127.48	2783	3-Feb-1973	422552	SBMNH	2	1
45.61	-126.71	2730	17-Feb-1971	422556	SBMNH	2	1
45.64	-126.80	2721	17-Feb-1971	422546	SBMNH	3	1
45.65	-125.81	2425	19-Mar-1970	422514	SBMNH	6	1
45.66	-125.81	2450	19-Mar-1970	422519	SBMNH	15	1
45.84	-126.48	2651	17-Jan-1970	422555	SBMNH	2	1
45.92	-127.58	2765	17-May-1971	422553	SBMNH	2	1
45.94	-127.64	2763	13-Mar-1973	422526	SBMNH	1	1

Localities of *Sicyonis careyi* n. sp. (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Number of Specimens	Source
45.95	-127.55	2763	11-Mar-1973	422564	SBMNH	2	1
45.96	-125.77	2265	20-Mar-1970	422538	SBMNH	1	1
46.03	-127.53	2740	12-Mar-1973	422554	SBMNH	4	1
46.04	-126.56	2706	15-Feb-1971	211931	SBMNH	1	1
48.73 to 48.70	-126.50 to -126.52	550	25-Feb-1988	988-00261-028	RBCM	21	1
CALIFORNIA: Monterey County: off Point Sur		1580-1622	26-Jul-1984	183918	CAS	2	1
OREGON		2850	27-Apr-1996	110758	CAS	1	1
OREGON		2520	--	422513	SBMNH	5	1
OREGON: OSU offshore station: OTB 112		2810	27-Mar-1966	422520	SBMNH	9	1

Appendix 11.

Localities of *Bathyphellia australis*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
-67.92 to -67.90	-110.92 to -110.00	3954-4042	14-Apr-1965	29637	CAS	P	1	1,6
-62.92 to -62.85	-78.90 to -78.72	4575	17-Nov-1963	29636	CAS	P	1	1,6
-59.80 to -59.85	-144.75 to -144.82	3200-3259	--	60705	USNM	P	1	1,6
-58.95 to -58.97	-74.78 to -74.53	4575	9-Nov-1963	17958	CAS	P	1	1,6
-55.37 to -55.37	-78.35 to -78.13	4319	--	60194	USNM	H	1	1,6
33.97	-132.25	3585	6-Oct-1972	71096	CAS	--	2	1
34.65	-122.97	4100	17-Jun-1994	001270	KUIZ	--	153	1
″	″	″	″	001279	KUIZ	--	10	1
″	″	″	″	001309	KUIZ	--	4	1
″	″	″	20-Jul-1993	001368	KUIZ	--	14	1
″	″	″	17-Jun-1994	001428	KUIZ	--	4	1
34.67	-123.05	4100	1-May-1995	001297	KUIZ	--	90	1
34.67	-123.12	4100	22-Jul-1991	001352	KUIZ	--	5	1
34.67	-123.13	4100	9-Oct-1996	001271	KUIZ	--	58	1
″	″	″	Oct-1996	001433	KUIZ	--	6	1
34.67	-123.18	4100	1996	001432	KUIZ	--	8	1
″	″	″	3-Jun-1995	001269	KUIZ	--	83	1
″	″	″	″	001377	KUIZ	--	10	1
″	″	″	22-Sep-1994	001276	KUIZ	--	88	1
″	″	″	″	001373	KUIZ	--	9	1
″	″	″	5-Jun-1996	001277	KUIZ	--	55	1
″	″	″	9-Jun-1995	001303	KUIZ	--	34	1
″	″	″	31-May-1996	001378	KUIZ	--	24	1
″	″	″	″	001395	KUIZ	--	26	1
34.68	-123.08	4100	5-Feb-1994	001268	KUIZ	--	88	1
″	″	″	″	001366	KUIZ	--	8	1
″	″	″	10-Feb-1994	001367	KUIZ	--	9	1
34.68	-123.13	4100	30-Oct-1989	002167	KUIZ	--	16	1
″	″	″	″	75774	CAS	--	9	1
34.68	-123.18	4100	10-Feb-1994	001273	KUIZ	--	59	1
″	″	″	Feb-1994	001426	KUIZ	--	20	1
″	″	″	″	001427	KUIZ	--	10	1

Localities of *Bathyphellia australis* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
34.70	-123.07	4100	20-Jul-1993	001300	KUIZ	--	45	1
34.70	-123.08	4100	17-Feb-1995	001274	KUIZ	--	81	1
34.70	-123.11	4100	1-Feb-1995	001376	KUIZ	--	8	1
34.70	-123.13	4100	20-Jul-1993	001362	KUIZ	--	8	1
″	″	″	7-Nov-1993	001364	KUIZ	--	2	1
34.70	-123.15	4100	14-Feb-1995	001434	KUIZ	--	112	1
34.70	-123.18	4100	31-Jan-1996	001296	KUIZ	--	12	1
″	″	″	″	001302	KUIZ	--	8	1
34.70	-123.23	4100	22-Oct-1994	001374	KUIZ	--	4	1
″	″	″	″	001375	KUIZ	--	7	1
″	″	″	″	001429	KUIZ	--	4	1
″	″	″	″	001430	KUIZ	--	4	1
34.72	-123.03	4100	14-Nov-1995	001308	KUIZ	--	26	1
34.72	-123.10	4100	19-Jul-1993	001281	KUIZ	--	75	1
″	″	″	″	001361	KUIZ	--	9	1
″	″	″	″	001307	KUIZ	--	4	1
″	″	″	″	001421	KUIZ	--	6	1
″	″	″	″	001422	KUIZ	--	5	1
″	″	″	″	001423	KUIZ	--	5	1
″	″	″	Nov-1995	001431	KUIZ	--	3	1
″	″	″	2-Aug-1991	001404	KUIZ	--	5	1
″	″	″	″	001290	KUIZ	--	75	1
″	″	″	19-Nov-1995	001304	KUIZ	--	12	1
34.72	-123.11	4100	Aug-1991	001401	KUIZ	--	2	1
″	″	″	″	001402	KUIZ	--	3	1
″	″	″	″	001403	KUIZ	--	4	1
34.72	-123.12	4100	1-Aug-1991	001353	KUIZ	--	4	1
34.72	-123.13	4100	20-Oct-1992	001287	KUIZ	--	20	1
34.72	-123.17	4100	23-Oct-1990	001284	KUIZ	--	54	1
″	″	″	″	001294	KUIZ	--	21	1
″	″	″	″	001349	KUIZ	--	3	1
″	″	″	″	001350	KUIZ	--	3	1
″	″	″	″	001351	KUIZ	--	2	1
″	″	″	″	001397	KUIZ	--	2	1

Localities of *Bathyphellia australis* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
34.72	-123.23	4100	22-Oct-1994	001272	KUIZ	--	90	1
″	″	″	12-Oct-1996	001275	KUIZ	--	91	1
34.73	-123.00	4100	24-Jun-1990	001299	KUIZ	--	15	1
34.73	-123.12	4100	22-Jul-1991	001288	KUIZ	--	67	1
34.73	-123.13	4100	21-Feb-1992	001298	KUIZ	--	45	1
″	″	″	24-Jun-1990	001346	KUIZ	--	3	1
″	″	″	25-Jun-1990	001347	KUIZ	--	4	1
″	″	″	″	001348	KUIZ	--	2	1
″	″	″	21-Feb-1992	001410	KUIZ	--	3	1
″	″	″	″	001411	KUIZ	--	3	1
″	″	″	″	001357	KUIZ	--	7	1
34.73	-123.18	4100	18-Feb-1990	001311	KUIZ	--	10	1
″	″	″	″	001344	KUIZ	--	4	1
34.73	-123.20	4100	4-Nov-1993	001280	KUIZ	--	146	1
″	″	″	″	001363	KUIZ	--	8	1
″	″	″	″	001365	KUIZ	--	5	1
″	″	″	″	001424	KUIZ	--	6	1
″	″	″	″	001425	KUIZ	--	5	1
34.73	-123.22	4100	21-Aug-1994	001278	KUIZ	--	108	1
″	″	″	″	001295	KUIZ	--	11	1
″	″	″	″	001369	KUIZ	--	2	1
″	″	″	″	001370	KUIZ	--	8	1
″	″	″	″	001371	KUIZ	--	2	1
″	″	″	20-Jul-1993	001372	KUIZ	--	6	1
34.75	-123.03	4100	24-Feb-1993	001282	KUIZ	--	77	1
″	″	″	″	001359	KUIZ	--	7	1
″	″	″	″	001416	KUIZ	--	3	1
″	″	″	″	001417	KUIZ	--	3	1
″	″	″	″	001418	KUIZ	--	5	1
″	″	″	″	001419	KUIZ	--	4	1
″	″	″	″	001360	KUIZ	--	35	1
″	″	″	″	001415	KUIZ	--	3	1
″	″	″	″	001420	KUIZ	--	5	1
34.75	-123.07	4100	21-Oct-1991	001286	KUIZ	--	71	1

Localities of *Bathyphellia australis* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
34.75	-123.07	4100	21-Oct-1991	001354	KUIZ	--	5	1
″	″	″	″	001405	KUIZ	--	2	1
″	″	″	″	001506	KUIZ	--	5	1
″	″	″	″	001407	KUIZ	--	4	1
″	″	″	″	001412	KUIZ	--	3	1
″	″	″	25-Oct-1991	001355	KUIZ	--	1	1
34.75	-123.12	4100	24-Jun-1991	001289	KUIZ	--	53	1
34.75	-123.18	4100	24-Jun-1991	001305	KUIZ	--	11	1
″	″	″	″	001399	KUIZ	--	5	1
″	″	″	″	001400	KUIZ	--	5	1
34.77	-123.10	4100	20-Feb-1991	001291	KUIZ	--	75	1
″	″	″	″	001356	KUIZ	--	5	1
″	″	″	″	001398	KUIZ	--	5	1
34.77	-123.13	4100	Oct-1992	001414	KUIZ	--	3	1
″	″	″	17-Oct-1992	001293	KUIZ	--	121	1
34.78	-123.07	4100	26-Feb-1992	001310	KUIZ	--	17	1
″	″	″	″	001408	KUIZ	--	4	1
″	″	″	″	001409	KUIZ	--	2	1
34.78	-123.12	4134	21-Jun-1992	001283	KUIZ	--	27	1
″	″	″	″	001292	KUIZ	--	40	1
″	″	″	″	001306	KUIZ	--	4	1
″	″	″	″	001358	KUIZ	--	5	1
″	″	″	″	001413	KUIZ	--	4	1
34.80	-123.00	4100	26-Oct-1989	001285	KUIZ	--	37	1
″	″	″	″	001345	KUIZ	--	7	1
34.82	-123.12	4100	25-Jun-1989	001342	KUIZ	--	3	1
″	″	″	″	001343	KUIZ	--	3	1
″	″	″	″	001382	KUIZ	--	36	1
″	″	″	″	001396	KUIZ	--	10	1
34.83	-123.00	4100	--	--	--	--	--	7
34.83 to 34.86	-123.22 to -123.26	4080	--	002173	KUIZ	--	29	1
38.68	-126.45	4292	--	422491	SBMNH	--	15	1
39.59	-127.41	4275	9-Dec-1981	422487	SBMNH	--	20	1
40.22	-126.50	4194	14-Jan-1966	422506	SBMNH	--	4	1

Localities of *Bathyphellia australis* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
44.10	-125.38	2940	14-Jun-1972	211952	SBMNH	--	1	1
44.50	-134.73	3858	5-Jun-1970	211953	SBMNH	--	1	1
44.67	-133.62	3724	3-Jun-1970	71094	CAS	--	1	1
44.68	-133.44	3717	4-May-1970	422495	SBMNH	--	2	1
44.72	-127.38	3021	12-Jun-1974	422501	SBMNH	--	3	1
44.72	-134.72	3860	1-Mar-1967	422493	SBMNH	--	3	1
44.74	-127.43	2749	2-Feb-1973	422497	SBMNH	--	2	1
44.74	-127.48	2818	3-Feb-1973	422492	SBMNH	--	1	1
44.95	-132.19	3580	6-Oct-1971	71093	CAS	--	1	1
44.97	-133.24	3500	7-Oct-1972	71099	CAS	--	1	1
45.00	-124.49	2884	5-Nov-1973	422500	SBMNH	--	1	1
45.00	-132.20	3585	5-Oct-1972	71101	CAS	--	2	1
45.02	-135.23	3932	10-Oct-1972	71095	CAS	--	1	1
45.03	-127.52	2850	5-Nov-1973	422499	SBMNH	--	1	1
″	″	″	″	422502	SBMNH	--	2	1
45.04	-127.54	2838	5-Nov-1973	422504	SBMNH	--	2	1
45.04	-134.70	3980	9-Oct-1972	71097	CAS	--	1	1
45.05	-135.38	3990	11-Oct-1972	71098	CAS	--	1	1
45.53	-127.47	2780	3-Feb-1973	422498	SBMNH	--	1	1
45.92	-127.54	2765	17-May-1971	422503	SBMNH	--	2	1
45.95	-127.55	2763	11-Mar-1973	422505	SBMNH	--	1	1
OREGON		2709	24-Aug-1965	71092	CAS	--	1	1
OREGON		--	--	71102	CAS	--	18	1
OREGON		4250	--	422488	SBMNH	--	31	1
OREGON		--	--	71103	CAS	--	15	1
OREGON		4250	--	422490	SBMNH	--	32	1
OREGON		4200	--	422489	SBMNH	--	20	1
OREGON		4275	--	422494	SBMNH	--	11	1
OREGON		4300	--	422496	SBMNH	--	5	1

Appendix 12.

Localities of *Actinauge verrillii*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
-48.15 to -48.17	148.28 to 148.25	1790-1803	--	59704	USNM	--	1	6
-45.55 to -45.50	147.30 to 147.13	2804-3100	26-Feb-1967	13747	CAS	--	11	1,6
-38.13	-75.88	1238 [677 fm]	--	--	--	S	7	5
-0.48	-89.91	717 [392 fm]	--	--	--	S	1	5
33.13	-118.67	757	8-May-1888	017807	USNM	S	8	1,5
34.56 to 34.57	-122.98 to -122.96	797	25-Oct-1997	001568	KUIZ	--	2	1
34.63	-123.02	4134	22-Jul-1992	001314	KUIZ	--	2	1
34.67	-123.05	4100	1-May-1995	001320	KUIZ	--	2	1
34.67	-123.13	4100	9-Oct-1996	001322	KUIZ	--	7	1
34.67	-123.18	4100	9-Jun-1995	001313	KUIZ	--	5	1
″	″	″	3-Jun-1995	001321	KUIZ	--	7	1
″	″	″	31-May-1996	001323	KUIZ	--	12	1
″	″	″	5-Jun-1996	001326	KUIZ	--	3	1
″	″	″	22-Sep-1994	001334	KUIZ	--	1	1
34.68	-123.18	4100	10-Feb-1994	001337	KUIZ	--	6	1
″	″	″	Feb-1994	001319	KUIZ	--	1	1
34.70	-123.05	4100	25-Oct-1991	001330	KUIZ	--	4	1
34.70	-123.08	4100	18-Feb-1995	001340	KUIZ	--	1	1
34.70	-123.15	4100	14-Feb-1995	001336	KUIZ	--	5	1
34.70	-123.23	4100	22-Oct-1994	001331	KUIZ	--	1	1
34.72	-123.10	4100	19-Nov-1995	001316	KUIZ	--	6	1
″	″	″	19-Jun-1993	001327	KUIZ	--	1	1
34.72	-123.12	4100	1-Aug-1991	001324	KUIZ	--	6	1
34.72	-123.17	4100	23-Oct-1990	001317	KUIZ	--	3	1
34.72	-123.23	4100	12-Oct-1996	001325	KUIZ	--	2	1
34.73	-123.12	4100	22-Jul-1991	001338	KUIZ	--	5	1
34.73	-123.13	4100	24-Jun-1990	001335	KUIZ	--	1	1
″	″	″	21-Feb-1992	001339	KUIZ	--	2	1
34.73	-123.18	4100	18-Feb-1990	001315	KUIZ	--	7	1
34.73	-123.20	4100	4-Nov-1993	001318	KUIZ	--	3	1
34.75	-123.03	4100	24-Feb-1993	001333	KUIZ	--	3	1
34.77	-123.10	4100	20-Feb-1991	001328	KUIZ	--	2	1

Localities of *Actinauge verrillii* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
34.77	-123.13	4100	17-Oct-1992	001329	KUIZ	--	2	1
34.78	-123.12	--	21-Jun-1992	001332	KUIZ	--	1	1
34.82	-123.12	4100	25-Jun-1989	001341	KUIZ	--	1	1
34.98 to 35.00	-122.55 to -122.54	481	26-Oct-1997	001566	KUIZ	--	5	1
35.42 to 35.44	-122.50 to -122.49	898	27-Oct-1997	001567	KUIZ	--	2	1
35.81 to 35.83	-122.17 to -122.17	1071	28-Oct-1997	001569	KUIZ	--	70	1
36.69 to 36.71	-122.19 to -122.22	1034-1107	18-Nov-1975	21249	CAS	--	7	1
″	″	″	″	21250	CAS	--	1	1
″	″	″	″	21288	CAS	--	13	1
40.05	-70.47	247-293 [135-160 fm]	--	--	--	--	--	9
42.18	-65.93	229	--	--	NEFSC	--	1	8
″	″	″	--	--	--	--	--	9
42.33	-67.47	289	--	--	NEFSC	--	1	8
42.83	-69.00	187	--	--	NEFSC	--	1	8
43.27	-125.84	3000	27-Jul-1965	211949	SBMNH	--	3	1
43.73	-125.43	3000	17-Jun-1972	422680	SBMNH	--	6	1
43.74	-125.43	2992	16-Jun-1972	422678	SBMNH	--	8	1
44.05	-125.39	2938	15-Jun-1972	422664	SBMNH	--	12	1
44.08	-125.41	2938	15-Jun-1972	422659	SBMNH	--	75	1
44.35	-125.23	1530	14-Oct-1964	422658	SBMNH	--	65	1
44.40	-125.59	2893	4-Aug-1974	83594	SBMNH	--	5	1
44.47	-125.54	2800	13-Jan-1965	422655	SBMNH	--	17	1
″	″	″	29-Apr-1963	422683	SBMNH	--	7	1
44.50	-125.40	2772	9-Apr-1965	422656	SBMNH	--	70	1
44.54	-125.59	2810	27-Mar-1966	422690	SBMNH	--	5	1
44.55	-128.32	2820	3-Nov-1973	422705	SBMNH	--	9	1
44.56	-125.57	2809	14-Oct-1966	422662	SBMNH	--	7	1
44.58	-125.66	2862	17-Jul-1968	422712	SBMNH	--	2	1
44.59	-125.20	1600	15-Jan-1968	422674	SBMNH	--	1	1
44.59	-125.57	2853	15-Oct-1966	422696	SBMNH	--	5	1
44.61	-125.63	2772	17-Jun-1964	422667	SBMNH	--	1	1
44.61	-126.13	3000	30-Dec-1968	422661	SBMNH	--	20	1
44.63	-125.67	2816	16-Mar-1970	422697	SBMNH	--	8	1
44.64	-126.06	2850	31-May-1963	422702	SBMNH	--	2	1

Localities of *Actinauge verrillii* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
44.64	-126.92	2806	23-Oct-1965	422711	SBMNH	--	14	1
44.65	-124.61	2865	18-May-1964	422673	SBMNH	--	1	1
44.65	-125.50	2800	29-Mar-1969	422687	SBMNH	--	10	1
44.65	-125.60	2865	19-May-1964	422663	SBMNH	--	1	1
44.65	-127.46	2826	9-Feb-1965	422698	SBMNH	--	3	1
44.66	-126.08	2794	23-Oct-1965	422682	SBMNH	--	12	1
44.67	-125.68	2850	30-Oct-1963	422695	SBMNH	--	1	1
44.67	-126.35	2860	20-May-1964	422671	SBMNH	--	1	1
44.67	-128.43	2794	3-Nov-1973	422700	SBMNH	--	1	1
44.68	-125.59	2800	14-Jan-1968	422681	SBMNH	--	6	1
44.68	-125.62	2800	26-Jul-1967	422718	SBMNH	--	1	1
44.69	-125.60	2779	6-Oct-1969	422704	SBMNH	--	13	1
44.69	-125.86	2833	21-Aug-1965	422707	SBMNH	--	9	1
44.70	-125.62	2800	20-Feb-1964	422685	SBMNH	--	2	1
44.71	-125.53	2825	6-Oct-1969	422693	SBMNH	--	11	1
44.72	-134.72	3860	1-Mar-1967	211947	SBMNH	--	9	1
44.73	-124.50	2510	31-Oct-1967	211948	SBMNH	--	2	1
44.73	-127.46	2803	2-Feb-1973	422713	SBMNH	--	3	1
44.74	-125.62	2830	28-Mar-1969	422708	SBMNH	--	1	1
44.74	-125.69	2800	24-Oct-1965	422660	SBMNH	--	10	1
44.74	-127.43	2749	2-Feb-1973	422694	SBMNH	--	3	1
44.74	-129.30	2709	24-Aug-1965	422670	SBMNH	--	1	1
44.75	-125.61	2800	25-Jul-1967	422715	SBMNH	--	4	1
44.75	-125.99	2800	12-Jan-1965	422657	SBMNH	--	44	1
″	″	″	12-Aug-1964	422688	SBMNH	--	9	1
44.76	-127.40	2790	22-Oct-1965	422672	SBMNH	--	1	1
44.77	-127.67	2600	17-Aug-1963	422669	SBMNH	--	1	1
44.92	-127.47	2838	4-Nov-1973	422699	SBMNH	--	4	1
44.92	-125.58	2706	16-Jul-1969	422689	SBMNH	--	6	1
44.94	-125.66	2760	17-May-1970	422701	SBMNH	--	5	1
45.00	-127.49	2884	5-Nov-1973	422665	SBMNH	--	1	1
45.01	-135.38	3990	17-Aug-1968	422686	SBMNH	--	1	1
45.03	-135.39	3990	11-Oct-1972	422709	SBMNH	--	1	1
45.06	-125.58	2652	5-Oct-1969	422692	SBMNH	--	1	1

Localities of *Actinauge verrillii* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
45.30	-125.79	2605	15-Mar-1970	422679	SBMNH	--	1	1
45.35	-125.62	2500	5-Oct-1969	422675	SBMNH	--	2	1
45.58	-126.34	2661	17-Jan-1970	422666	SBMNH	--	1	1
45.60	-125.61	2283	14-Jul-1969	422703	SBMNH	--	2	1
45.66	-125.81	2450	19-Mar-1970	422684	SBMNH	--	3	1
45.94	-127.64	2763	13-Mar-1973	422668	SBMNH	--	1	1
45.95	-127.55	2763	11-Mar-1973	422677	SBMNH	--	1	1
45.96	-126.63	2743	14-Jan-1971	422676	SBMNH	--	1	1
48.22	-125.82	512	14-Jun-1985	985-00471-011	RBCM	--	1	1
48.28 to 48.27	-125.96 to -125.96	466-470	13-Oct-2005	010-00182-001	RBCM	--	1	1
48.33 to 48.32	-126.40 to -126.37	1160-1175	3-Sep-2001	010-00172-001	RBCM	--	3	1
48.41 to 48.39	-126.10 to -126.09	275	8-Feb-1972	A-241-00004	RBCM	--	1	1
48.42 to 48.41	-126.34 to -126.45	1100	6-Feb-1990	990-00325-028	RBCM	--	4	1
48.43 to 48.40	-126.14 to -126.14	315	23-Feb-1988	988-00258-002	RBCM	--	24	1
48.73 to 48.70	-126.50 to -126.52	550	25-Feb-1988	988-00261-031	RBCM	--	25	1
49.07	-126.93	458-462	22-Jul-1999	009-00055-011	RBCM	--	2	1
49.17 to 49.19	-127.07 to -127.09	526-569	5-Apr-2003	003251	KUIZ	--	2	1
49.22 to 49.21	-127.07 to -127.05	400-500	28-Feb-1988	988-00267-021	RBCM	--	4	1
49.35	-127.26	560-660	27-Jul-1999	010-00083-008	RBCM	--	2	1
49.42	-127.37	1000-1166	3-Feb-1990	990-00320-033	RBCM	--	1	1
51.20 to 51.22	-130.04 to -130.07	571-621	15-Oct-2006	010-00193-003	RBCM	--	8	1
51.33	-52.42	424 [232 fm]	--	--	--	--	--	9
52.00	-131.23	--	10-Mar-1991	991-00327-001	RBCM	--	2	1
53.02	-132.92	1189 [650 fm]	Aug-1965	21251	CAS	--	13	1
52.03 to 52.00	-131.60 to -131.57	1636-1900	30-Aug-2000	009-00078-015	RBCM	--	1	1
52.08 to 52.09	-131.53 to -131.52	1396-1523	5-Aug-2004	010-00216-005	RBCM	--	5	1
52.75 to 52.74	-132.43 to -132.41	819-936	7-Sep-2004	010-00181-001	RBCM	--	3	1
53.06	-132.98	1225-1240	21-Mar-1991	991-00332-013	RBCM	--	5	1
″	″	″	″	991-00332-043	RBCM	--	20	1
″	″	″	″	991-00332-051	RBCM	--	1	1
53.40	-130.11	315 [172 fm]	15-Sep-1978	28467	CAS	--	5	1
54.34 to 54.35	-133.06 to -133.02	457-466	1-Sep-2002	003271	KUIZ	--	10	1
55.55	-133.63	1920 [1050 fm]	Aug-65	21253	CAS	--	1	1
57.29	-136.29	--	16-Sep-1996	001148	KUIZ	--	1	1

Localities of *Actinauge verrillii* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
59.14	-141.55	325.7	11-Nov-1979	20192	CAS	--	1	1
63.50	-54.40	1064 [582 fm]	--	--	--	--	--	9
65.50	-55.43	529 [289 fm]	--	--	--	--	--	9
65.57	-54.52	124 [68 fm]	--	--	--	--	--	9
65.60	-56.40	638 [349 fm]	--	--	--	--	--	9
66.58	-56.63	582 [318 fm]	--	--	--	--	--	9
66.70	-56.20	--	--	--	--	--	--	9
66.73	-56.13	320 [175 fm]	--	--	--	--	--	9
66.82	-56.47	430 [235 fm]	--	--	--	--	--	9
68.35	-54.08	402-512 [220-280 fm]	--	--	--	--	--	9
70.85	-52.02	733	--	--	--	--	--	9
70.88	-54.05	100	--	--	--	--	--	9
73.20	-58.13	850	--	--	--	--	--	9
″	″	″	--	--	--	--	33	11
74.20	-77.00	680	--	--	--	--	--	9
74.87	-62.20	450	--	--	--	--	--	9
75.43	-66.43	820	--	--	--	--	--	9
77.08	-71.55	790	--	--	--	--	--	9
77.48	-68.77	875	--	--	--	--	--	9
ATLANTIC OCEAN: Gulf Stream: Slope		157-2008 [86-1098 fm]	--	--	--	--	--	12
CHESAPEAKE BAY: off Chesapeake Bay		157-2008 [86-1098 fm]	--	--	--	--	--	12
MASSACHUSETTS: 80 miles south of Martha's Vineyard		--	--	--	--	--	--	9
MASSACHUSETTS: Martha's Vineyard		157-2008 [86-1098 fm]	--	--	--	--	--	12
MASSACHUSETTS: Nantucket		157-2008 [86-1098 fm]	--	--	--	--	--	12
NEW YORK: Long Island		157-2008 [86-1098 fm]	--	--	--	--	--	12
GREENLAND: West Greenland: Davis Strait		768 [420 fm]	--	--	--	--	--	9
GREENLAND: West Greenland: Davis Strait: Baffin Bay		457 [250 fm]	--	--	--	--	--	9
GREENLAND: West Greenland: Davis Strait: Baffin Bay: Discofjord		238 [130 fm]	--	--	--	--	--	9
GREENLAND: West Greenland: Davis Strait: Baffin Bay: Discofjord: Nipisite harbour		18-37 [10-20 fm]	--	--	--	--	--	9
GREENLAND: West Greenland: Davis Strait: Baffin Bay: Upernavik		--	--	--	--	--	--	9

Localities of *Actinauge verrillii* (continued)

Locality	Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
GREENLAND: West Greenland: Kvanefjord	420	--	--	--	--	--	9
GREENLAND: West Greenland: Kvanefjord	300-500	--	--	--	--	--	9
GREENLAND: West Greenland: Kvanefjord	200-410	--	--	--	--	--	9
GREENLAND: West Greenland: Umanak	726 [397 fm]	--	--	--	--	--	9
GREENLAND: West Greenland: Umanakfjord	475 [260 fm]	--	--	--	--	--	9
ICELAND: Hali:off Isafjarðardjup	170-235	--	--	--	--	--	9,10
ICELAND: Reyðarfjörður	226	--	--	--	--	--	9,10
CALIFORNIA: Monterey Bay: off Soberanes Point	1409-1384	21-Nov-1975	110759	CAS	--	77	1
CALIFORNIA: Monterey County: Point Sur:	1400-1430	6-Feb-1985	96872	CAS	--	1	1
CALIFORNIA: off Monterey Bay	1336-1347	19-Nov-1975	104105	CAS	--	3	1
CALIFORNIA	251	22-Jun-1998	175189	CAS	--	3	1
CALIFORNIA: San Francisco County: Farallon Islands	1463-1646 [800-900 fm]	2-Sep-1977	96877	CAS	--	10	1
OREGON	400	2-Apr-1973	122247	CAS	--	4	1
OREGON	2850	27-Apr-1996	110757	CAS	--	1	1
OREGON	4250	--	422706	SBMNH	--	2	1
ALASKA: Aleutian Islands	332	3-Jun-2002	175091	CAS	--	1	1
ALASKA: Aleutian Islands	1039	30-Jun-2004	175936	CAS	--	3	1
ALASKA: Aleutian Islands	529-539	21-May-1999	183893	CAS	--	8	1
ALASKA: Gulf of Alaska: South of Kodiak Island	238 [130 fm]	14-Sep-1963	21255	CAS	--	2	1
ALASKA: Gulf of Alaska: off Kodiak Island	119 to 123 [65-67 fm]	26-Sep-1978	96869	CAS	--	3	1
BRITISH COLUMBIA: Queen Charlotte Islands; Moresby Island; West coast of island	732 [400 fm]	Jul-1977	001-00048-001	RBCM	--	4	1
CANADA: Gulf of St. Lawrence: St. Lawrence estuary	50-330	--	--	--	--	--	9

Appendix 13.

Localities of *Monactis vestita*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
12.50	-64.75	3476-3518	--	--	--	--	17	15
13.75	-67.75	5047	--	--	--	--	49	15
″	″	5046	--	--	--	--	22	15
14.50	-67.25	5055-5060	--	--	--	--	65	15
15.13	-69.20	3993-4065	--	--	--	--	21	15
″	″	3967-4009	--	--	--	--	19	15
32.47	-16.63	2286	--	13 0080	MOM	S	2	14
38.91	-21.21	5005	--	13 0022	MOM	S	11	14
41.82 to 41.66	-13.91 to -13.80	5320	--	--	--	--	5	15
42.96 to 42.87	-14.89 to -14.79	5200	--	--	--	--	3	15
44.68	-133.44	3717	5-Apr-1970	144459	SBMNH	--	19	1,4
45.02	-135.23	3932	10-Oct-1972	001210	KUIZ	--	11	1,4
″	″	″	″	144419	SBMNH	--	248	1,4
″	″	″	″	119154	CAS	--	6	1,4
45.03	-134.70	3900	9-Oct-1972	144423	SBMNH	--	153	1,4
″	″	″	″	999-00262-001	RBCM	--	3	1,4
45.03	-135.39	3990	--	1972-386.001	LACM	--	7	4
″	″	″	10-Oct-1972	144460	SBMNH	--	74	1,4
45.06	-134.75	3900	10-Oct-1972	144461	SBMNH	--	71	1,4
″	″	″	--	100314	USNM	--	5	4
45.08	-133.18	3700	7-Oct-1972	144422	SBMNH	--	11	1,4
45.09	-134.72	3900	9-Oct-1972	144424	SBMNH	--	39	1,4
46.52	-10.33	4706	--	--	--	--	7	15
60.63	-8.62	350	25-Jul-1989	--	--	--	--	13
60.67	-11.68	914	26-Jul-1989	--	--	--	--	13
60.74	-12.62	702	28-Jul-1989	--	--	--	--	13
60.80	-12.68	1006	28-Jul-1989	--	--	--	--	13
60.95	-4.31	1150	21-Jul-1989	--	--	--	--	13
62.08	-6.66	59	--	--	--	--	--	13

Appendix 14.

Localities of *Paraphelliactis pabista*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
26.99 to 27.02	-111.41 to -114.41	2033-2034	9-10-Oct-1990	--	--	--	2	17
27.00	-111.40	1950-2050	11-Oct-1990	--	--	--	1	17
″	″	2000	--	--	--	--	3	17
34.67	-123.18	4100	31-May-1996	003314	KUIZ	--	1	1
34.82	-123.12	4100	25-Jun-1989	75776	CAS	--	1	1
43.27	-125.84	3000	27-Jul-1965	211921	SBMNH	--	7	1
43.33	-125.17	1600	4-Apr-1973	422736	SBMNH	--	1	1
43.39	-125.31	2000	4-Apr-1973	422732	SBMNH	--	1	1
44.05	-125.39	2938	15-Jun-1972	422749	SBMNH	--	1	1
44.38	-125.58	2878	4-Aug-1974	422729	SBMNH	--	7	1
44.40	-125.24	2000	14-Aug-1961	422733	SBMNH	--	2	1
44.40	-125.59	2893	4-Aug-1974	83592	SBMNH	--	7	1
44.45	-125.26	2000	14-Aug-1961	422727	SBMNH	--	22	1
44.45	-132.23	3655	1-Jun-1970	422753	SBMNH	--	1	1
44.47	-125.54	2800	13-Jan-1965	422738	SBMNH	--	8	1
44.50	-125.40	2772	9-Apr-1965	422759	SBMNH	--	5	1
44.50	-134.73	3858	--	422752	SBMNH	--	4	1
44.56	-125.57	2809	14-Oct-1966	422735	SBMNH	--	1	1
″	″	″	″	422751	SBMNH	--	3	1
44.58	-125.57	2807	15-Jul-1968	422731	SBMNH	--	2	1
44.58	-128.36	2820	3-Nov-1973	211914	SBMNH	--	1	1
44.59	-125.58	2853	15-Oct-1966	65148	CAS	--	2	1
44.59	-125.59	2800	29-Apr-1963	422743	SBMNH	--	1	1
″	″	2816	16-Mar-1970	422730	SBMNH	--	2	1
44.63	-125.67	2816	16-Mar-1970	422734	SBMNH	--	2	1
44.64	-126.68	2938	20-Feb-1971	211918	SBMNH	--	3	1
44.66	-125.21	1426	1961	211976	SBMNH	--	1	1
44.67	-128.19	2700	22-Oct-1965	422747	SBMNH	--	1	1
44.67	-133.60	3724	3-Jun-1970	211919	SBMNH	--	3	1
44.68	-125.59	2800	14-Jan-1968	422744	SBMNH	--	6	1
44.68	-125.62	2800	26-Jul-1967	83609	SBMNH	--	4	1
44.69	-125.60	2779	6-Oct-1969	422758	SBMNH	--	6	1

Localities of *Paraphelliactis pabista* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
44.73	-127.46	2803	11-Oct-1972	422741	SBMNH	--	1	1
44.74	-125.62	2830	28-Mar-1969	422760	SBMNH	--	7	1
44.74	-125.69	2800	15-Oct-1966	65150	CAS	--	3	1
44.75	-125.61	2800	25-Jul-1967	422754	SBMNH	--	3	1
44.91	-132.23	3685	5-Oct-1972	422750	SBMNH	--	2	1
44.92	-125.58	2706	4-Jul-1974	211916	SBMNH	--	1	1
44.92	-127.48	2838	4-Nov-1973	211917	SBMNH	--	2	1
44.94	-125.66	2760	17-Mar-1970	211915	SBMNH	--	1	1
44.95	-132.19	3580	5-Oct-1972	422745	SBMNH	--	2	1
44.97	-125.74	2790	19-Mar-1970	422748	SBMNH	--	1	1
44.97	-132.24	3500	6-Oct-1972	422757	SBMNH	--	2	1
″	″	3585	6-Oct-1972	422737	SBMNH	--	1	1
45.03	-127.52	2850	5-Nov-1973	422742	SBMNH	--	1	1
45.03	-134.70	3900	9-Oct-1972	422761	SBMNH	--	2	1
45.06	-125.58	2652	5-Oct-1969	422755	SBMNH	--	1	1
45.07	-133.18	3900	7-Oct-1972	211920	SBMNH	--	3	1
45.09	-134.72	3900	9-Oct-1972	422746	SBMNH	--	1	1
45.95	-127.55	2763	11-Mar-1973	422739	SBMNH	--	1	1
46.03	-127.53	2740	12-Mar-1973	422740	SBMNH	--	1	1
48.09	-126.18	1515	1984 [?]	50135	CAS	--	1	1
48.15	-127.07	2510	10-Sep-1971	422756	SBMNH	--	2	1
49.71	-127.95	2003-2091	15-Apr-2003	010-00177-002	RBCM	--	1	1
49.89	-127.38	1830	10-Sep-1964	28043	CAS	P	1	1,16
50.45	-130.12	1859-1903	8-Oct-2006	010-00188-002	RBCM	--	2	1
50.91	-130.10	2195 [1200 fm]	11-Sep-1964	25997	CAS	--	38	1,16
″	″	″	″	982-00001-001	RBCM	P	2	1,16
″	″	″	″	1982-0041	CMN	P	1	16
″	″	″	″	60379	USNM	P	2	16
51.26 to 51.27	-130.17 to -130.19	2003-2091	15-Apr-2003	003286	KUIZ	--	1	1
51.45	-131.79	2430	8-Aug-1965	25998	CAS	--	3	1,16
″	″	″	″	25999	CAS	P	2	1,16
51.72	-131.23	1829 [1000 fm]	5-Aug-1965	26000	CAS	P	2	1,16
″	″	″	″	1982-0038	CMN	H	1	16
53.55	-133.63	1920 [1050 fm]	Aug-1965	28040	CAS	P	1	1,16

Localities of *Paraphelliactis pabista* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
53.55	-133.63	1920 [1050 fm]	Aug-1965	28041	CAS	--	2	1,16
OREGON		2810	--	65149	CAS	--	7	1
OREGON		2500	1-Aug-1965	65151	CAS	--	2	1

Appendix 15.

Localities of *Liponema brevicorne*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
32.74 to 32.84	-119.48 to -119.54	1400	7-Jul-1989	68111	CAS	--	4	1
33.13	-118.67	757 [414 fm]	--	17802	USNM	S	2	5
34.63	-123.02	4134	22-Jul-1992	001380	KUIZ	--	1	1
34.65	-122.97	4100	17-Jun-1994	001384	KUIZ	--	1	1
34.67	-123.13	4100	9-Oct-1996	001389	KUIZ	--	1	1
34.67	-123.18	4100	3-Jun-1995	001388	KUIZ	--	1	1
″	″	″	5-Jun-1996	001950	KUIZ	--	1	1
34.67	-123.23	4100	12-Oct-1992	001390	KUIZ	--	1	1
34.68	-123.13	4100	30-Oct-1989	75775	CAS	--	5	1
34.70	-123.08	4100	17-Feb-1995	001387	KUIZ	--	1	1
34.70	-123.15	4100	14-Feb-1995	001386	KUIZ	--	1	1
34.72	-123.10	4100	19-Jul-1993	001383	KUIZ	--	3	1
34.73	-123.13	4100	24-Jun-1990	001379	KUIZ	--	1	1
34.73	-123.22	4100	21-Aug-1994	001385	KUIZ	--	1	1
34.75	-123.07	4100	21-Oct-1991	001951	KUIZ	--	1	1
34.77	-123.13	4100	18-Oct-1992	001381	KUIZ	--	1	1
34.98 to 35.00	-122.55 to -122.54	481	26-Oct-1997	001449	KUIZ	--	3	1
36.13	129.82	732 [400 fm]	30-Jul-1906	3829	CAS	--	1	1,19
36.49	-122.32	1409- 1419	3-Oct-1984	66641	CAS	--	4	1
36.61	-122.43	~3000	--	--	--	--		18
36.72 to 36.70	-122.22 to -122.18	992-1024	8-Apr-2009	003303	KUIZ	--	2	1
38.12	142.13	486 [266 fm]	10-Oct-1906	3826	CAS	--	5	1
43.73	-125.43	3000	17-Jun-1972	422777	SBMNH	--	6	1
44.08	145.50	548 [300 fm]	30-Sep-1906	3827	CAS	--	1	1
44.10	-125.38	2940	14-Jun-1972	422778	SBMNH	--	1	1
44.35	-125.23	1530	14-Aug-1964	422771	SBMNH	--	12	1
44.40	-125.07	1000	21-Jun-1962	422781	SBMNH	--	2	1
44.40	-125.17	1000	12-Aug-1964	422776	SBMNH	--	2	1
44.45	-125.22	1400	20-Jun-1962	422785	SBMNH	--	1	1
44.58	-125.04	1250	11-Apr-1965	422782	SBMNH	--	1	1
44.58	-125.66	2862	17-Jul-1968	422787	SBMNH	--	4	1
44.59	-125.20	1600	15-Jan-1968	422789	SBMNH	--	1	1

Localities of *Liponema brevicorne* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
44.69	-125.86	2833	21-Aug-1965	422779	SBMNH	--	1	1
44.73	-124.50	2510	31-Oct-1967	211950	SBMNH	--	1	1
44.74	-124.31	2030	31-Oct-1967	211951	SBMNH	--	18	1
44.76	-127.40	2790	22-Oct-1965	422780	SBMNH	--	1	1
45.00	-127.49	2884	5-Nov-1973	422786	SBMNH	--	1	1
45.03	-127.52	2850	5-Nov-1973	422788	SBMNH	--	1	1
45.06	-125.58	2652	Oct-1969	422790	SBMNH	--	1	1
45.83	-125.23	1540	26-Jul-1967	422774	SBMNH	--	33	1
45.86	-125.26	1600	25-Oct-1967	422784	SBMNH	--	3	1
46.03	-127.53	2740	12-Mar-1973	422783	SBMNH	--	1	1
46.73	144.03	933 [510 fm]	26-Sep-1906	3819	CAS	--	2	1,19
48.37 to 48.38	-126.46 to -126.47	1416-1433	29-Aug-2001	010-00168-003	RBCM	--	1	1
48.43 to 48.40	-126.14 to -126.14	315	23-Feb-1988	988-00258-001	RBCM	--	1	1
48.44 to 48.43	-126.39 to -126.37	1068-1101	29-Aug-2001	010-00167-001	RBCM	--	1	1
48.61	-127.01	2189	11-Sep-1971	422775	SBMNH	--	7	1
48.73 to 48.70	-126.50 to -126.52	550	25-Feb-1988	988-00261-020	RBCM	--	3	1
49.17 to 49.19	-127.07 to -127.09	526-569	5-Apr-2003	003253	KUIZ	--	1	1
49.33 to 49.37	-127.23 to -127.28	560-660	27-Jul-1999	010-00083-004	RBCM	--	2	1
49.51 to 49.51	-127.82 to -127.84	1955-2001	16-Apr-2002	003280	KUIZ	--	1	1
49.66 to 49.67	-127.60 to -127.61	580-584	16-Apr-2003	010-00178-001	RBCM	--	1	1
49.66 to 49.67	-127.60 to -127.84	580-584	14-Apr-2003	003250	KUIZ	--	2	1
51.72	-127.79	--	21-Oct-1982	002155	KUIZ	--	1	1
51.87	-127.94	318-320	19-Jan-1988	988-00003-021	RBCM	--	11	1
52.03 to 52.00	-131.60 to -131.57	1636-1900	30-Aug-2001	009-00078-005	RBCM	--	1	1
53.06	-132.98	1225-1240	21-Mar-1991	991-00332-026	RBCM	--	4	1
″	″	″	″	991-00332-059	RBCM	--	2	1
53.92	-133.82	1150	22-Mar-1991	991-00333-030	RBCM	--	1	1
54.08 to 54.07	-134.12 to -134.16	1722-2083	2-Sep-2002	003267	KUIZ	--	1	1
54.55	178.75	1019 [557 fm]	4-Jun-1906	3828	CAS	--	1	1,19
54.83	147.20	102 [56 fm]	14-Jun-1906	3805	CAS	--	1	1
55.07 to 55.08	-130.19 to -130.19	215-225	24-Jan-1988	988-00012-016	RBCM	--	2	1
55.51	-166.68	135	May-1976	--	--	--	14	19
55.52	-166.68	135	31-May-1976	3800	CAS	--	6	1
″	″	″	″	3801	CAS	--	2	1

Localities of *Liponema brevicorne* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
55.52	-166.68	135	31-May-1976	3802	CAS	--	1	1
″	″	″	″	3803	CAS	--	1	1
″	″	″	″	3804	CAS	--	1	1
CALIFORNIA		461	14-Jul-2001	175192	CAS	--	3	1
CALIFORNIA: Gulf of Farallones		510	13-Dec-1985	95090	CAS	--	3	1
CALIFORNIA: Gulf of Farallones		510	13-Dec-1985	96834	CAS	--	2	1
CALIFORNIA: Monterey County: off Point Sur		1580-1622	26-Jul-1984	69282	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		1400-1430	6-Feb-1985	66642	CAS	--	4	1
CALIFORNIA: Monterey County: off Point Sur		1000	Nov-1989	65165	CAS	--	2	1
CALIFORNIA: Monterey County: off Point Sur		1200-1250	6-Feb-1985	67930	CAS	--	1	1
CALIFORNIA: Monterey County: off Point Sur		1200	11-May-1984	183894	CAS	--	4	1
OREGON: off Newport		256	--	53305	USNM	--	1	19
OREGON		1700-2000	1-May-1996	110756	CAS	--	1	1
CANADA: British Columbia: North of Queen Charlotte Islands: Dixon Entrance		187 [102 fm]	28-May-1965	19868	CAS	--	2	1
ALASKA: Aleutian Islands		--	10-Jul-2002	183892	CAS	--	2	1
ALASKA: Aleutian Islands: north of Unalaska Island		580-680	10-Jun-1979	96532	CAS	--	1	1
ALASKA: Gulf of Alaska		533	22-Jun-1999	175117	CAS	--	1	1
ALASKA: Gulf of Alaska: vicinity of Aleutian Islands		299	18-May-1999	161246	CAS	--	1	1
JAPAN: north of Hokkaido		549	1906	--	CAS	--	1	19
JAPAN: off east coast of Northern Honshu		487	--	--	CAS	--	5	19
RUSSIA: off east coast of Kamchatka		103	1906	--	CAS	--	1	19
--	--	--	17-Sep-1978	24433	CAS	--	2	1

Appendix 16.

Localities of *Metridium farcimen*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
31.36	-113.63	--	7-Mar-1970	422766	SBMNH	--	1	1
32.68	-117.28	60 [33 fm]	10-Aug-1978	422767	SBMNH	--	1	1
34.25	-120.00	366 [200 fm]	1967	45514	SBMNH	--	1	1
34.47	-120.22	293 [160 fm]	Oct-1968	45513	SBMNH	--	1	1
″	″	256 [140 fm]	Sep-1967	45511	SBMNH	P	1	20
″	″	201 [110 fm]	1-Jul-1967	45512	SBMNH	P	1	20
34.49 to 34.51	-121.20 to -121.19	443	26-Oct-1997	001438	KUIZ	--	1	1
35.03 to 35.04	-121.10 to -121.10	199	24-Oct-1997	001435	KUIZ	--	5	1
″	″	″	″	001436	KUIZ	--	5	1
36.35 to 36.37	-123.82 to -123.82	817	29-Oct-1997	001464	KUIZ	--	1	1
36.63	-121.93	73-77 [40-42 fm]	10-May-1904	3349	CAS	H	1	1,20
37.82	-122.48	84	21-Oct-1912	85789	USNM	P	1	20
″	″	60-84 [33-46 fm]	15-Oct-1912	4371	CAS	--	4	1
″	″	--	21-Oct-1912	4372	CAS	--	2	1
″	″	73-75 [40-41 fm]	15-Oct-1912	4370	CAS	P	2	1,20
44.10	-125.38	2740	14-Jun-1972	422765	SBMNH	--	2	1
44.73	-124.31	--	25-Mar-1964	422768	SBMNH	--	1	1
48.30	-123.37	9 [30 ft]	18-Sep-1973	973-00251-012	RBCM	--	2	1
48.30	-123.53	12.2	6-Sep-1973	973-00249-010	RBCM	--	6	1
48.50	-122.68	--	--	--	--	--	--	24
48.73 to 48.73	-123.43 to -123.44	75-95	15-May-1978	978-00146-005	RBCM	--	1	1
48.76	-123.45	73-128 [40-70 ft]	10-Feb-1965	A-120-00002	RBCM	--	2	1
48.87	-123.31	--	30-Sep-1986	986-00197-008	RBCM	--	12	1
48.90	-125.32	<15	12-Jul-1973	973-00176-002	RBCM	--	2	1
49.37	-122.88	--	Jan-1960	976-00036-012	RBCM	--	1	1
49.38	126.27	0-3 [0-10 ft]	12-Jul-1980	980-00400-004	RBCM	--	1	1
49.53	-124.82	--	17-Jun-1976	989-00040-001	RBCM	--	3	1
49.59	-127.09	--	26-Jun-1976	989-00039-001	RBCM	--	1	1
49.95 to 50.00	-127.67 to -127.68	108-120	21-Mar-1986	986-00095-001	RBCM	--	2	1
50.05 to 50.09	-127.25 to -127.25	210	20-Nov-1983	983-01645-008	RBCM	--	3	1
50.72	-127.49	--	26-Jun-1976	989-00036-002	RBCM	--	7	1
52.18	-131.13	26.2	28-Jun-1999	999-00212-001	RBCM	--	1	1

Localities of *Metridium farcimen* (continued)

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
52.20 to 52.19	-131.25 to -131.25	54.8-63.5	17-Jun-1999	999-00210-003	RBCM	--	2	1
52.41	-131.60	--	30-Mar-1991	991-00330-058	RBCM	--	1	1
52.90 to 52.91	-128.68 to -128.68	198-220	31-Oct-1986	987-00313-001	RBCM	--	1	1
52.99	-130.76	52 f	13-Sep-1978	25556	CAS	--	4	1
53.10 to 53.11	-130.88 to -130.92	84	29-Jan-1986	986-00064-002	RBCM	--	3	1
53.60	-130.55	--	22-Jun-2005	005-00054-025	RBCM	--	1	1
54.15	-130.23	--	27-Oct-1974	975-00315-001	RBCM	--	1	1
54.19 to 54.21	-131.07 to -131.07	77	6-Feb-1986	986-00080-010	RBCM	--	5	1
54.20 to 54.23	-131.06 to -131.05	0	6-Feb-1986	986-00079-011	RBCM	P	1	1,20
54.23 to 54.25	-131.04 to -131.04	123	6-Feb-1986	986-00078-001	RBCM	--	6	1
54.81	-130.43	9	9-Jun-1974	974-00218-026	RBCM	--	1	1
56.77	-151.72	220	9-Sep-1963	69721	CAS	--	2	1
57.94	-173.02	116.0-117.1	27-May-1976	19826	CAS	--	4	1
65.68	-168.30	--	10-Aug-2004	002949	KUIZ	--	2	1
MEXICO: Guerrero: Acapulco bay		--	4-Apr-1932	96534	CAS	--	1	1
MEXICO: Sonora: Gulf of California: Guaymas		--	--	49458	USNM	H	1	23
MEXICO: Sonora: Gulf of California: Guaymas		--	--	331	MZLU	H	wedge	23
CALIFORNIA: 7.4 mi SSW of Point Piedras Blanca		441-457 [241-250 fm]	19-Jul-1977	96875	CAS	--	1	1
CALIFORNIA: Cordell Bank National Marine Sanctuary: off Cordell Bank		183 m [100 fm]	18-Jun-1951	3508	CAS	P	2	1,20
CALIFORNIA: Humboldt County: Eel River Canyon		--	Dec-1966	3341	CAS	--	1	1
CALIFORNIA: Monterey Bay		--	17-Apr-1980	96541	CAS	--	1	1
CALIFORNIA: Monterey Bay		88 [48 fm]	8-Feb-1970	108457	CAS	--	1	1
CALIFORNIA: Monterey Bay		104 [57 fm]	8-Feb-1970	108536	CAS	--	1	1
CALIFORNIA: Monterey Bay		55 [30 fm]	8-Feb-1970	108537	CAS	--	1	1
CALIFORNIA: Sonoma County: Bodega Jetty		--	12-Jun-1952 [?]	95086	CAS	--	1	1
OREGON: off Oregon coast: OSU offshore station: BMT 910		--	21-Apr-1975	422769	SBMNH	--	1	1
CANADA: British Columbia: Boundary Bay: Crescent Beach		--	1917	3505	CAS	--	1	1
CANADA: British Columbia: Strait of Georgia: N of Gabriola Island		15+ [50+ ft]	2-Jul-1963	19869	CAS	--	3	1
GULF OF ALASKA: off Kodiak Island		119-123 [65-67 fm]	26-Sep-1978	96876	CAS	--	1	1

Localities of *Metridium farcimen* (continued)

Locality	Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
ALASKA: Alexander Archipelago: Dutch Harbor	--	Sep-1897	21326	CAS	--	2	1
ALASKA: Bering Sea: Alaska Peninsula: NE of Cape Leontovich	43-46	13-Aug-1982	27724	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: off Port Moller	55	11-Aug-1982	27708	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: off Port Moller	50-51	21-Oct-1982	27733	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: off S end Izembek Lagoon	62-63	18-Oct-1982	27700	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: off S end Izembek Lagoon	43	26-Jun-1982	27732	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: SW of Port Moller	42-44	12-Aug-1982	27710	CAS	--	1	1
ALASKA: Bering Sea: Alaska Peninsula: SW of Port Moller	20	Oct-1982	27718	CAS	--	1	1
ALASKA: Bering Sea: east of Pribilof Islands	66	7-Jul-1979	21859	CAS	--	13	1
ALASKA: Kodiak Island	--	--	95100	CAS	--	2	1
ALASKA: Bering Sea	45	22-May-1976	26120	CAS	--	1	1
BERING SEA: off Pribilof Islands, W of St. George Island	113-117	18-Jun-1979	97389	CAS	--	3	1
RUSSIA: Kamchatka: Avacha [Awatcha] Bay	--	--	--	--	S	--	22
RUSSIA: Kamchatka: Petropaulowsk	--	--	--	--	S	--	21
--	--	--	3348	CAS	--	1	1

Appendix 17.

Localities of *Sagartiogeton californicus*

Locality		Depth (m)	Collection Date	Catalog Number	Repository	Type Status	Number of Specimens	Source
27.07	-111.90	73 [40 fm]	11-Apr-1936	--	--	S	2	25
34.89 to 34.91	-122.50 to -122.49	687	26-Oct-1997	001451	KUIZ	--	2	1
36.52 to 36.71	-122.19 to -122.22	1034-1107	18-Nov-1975	53178	CAS	--	2	1
36.80 to 36.81	-123.80 to -123.79	464	30-Oct-1997	001468	KUIZ	--	2	1
43.43	-124.86	658	4-Jul-1974	83608	SBMNH	--	14	1
″	″	665	--	144420	SBMNH	--	11	1
43.45	-124.81	530	--	144446	SBMNH	--	27	1
44.61	-124.94	800	10-Apr-1965	144418	SBMNH	--	1	1
44.67	-126.07	630	19-Feb-1970	144447	SBMNH	--	10	1
48.73 to 48.70	-126.50 to -126.52	550	25-Feb-1988	988-00261-029	RBCM	--	42	1
48.95 to 48.96	-126.97 to -126.98	1054-1075	17-Apr-2003	003290	KUIZ	--	1	1
49.33 to 49.37	-127.23 to -127.28	560-660	27-Jul-1999	010-00083-009	RBCM	--	1	1
49.42	-127.37	1000-1166	3-Feb-1990	990-00320-012	RBCM	--	7	1
49.51 to 49.50	-127.41 to -127.41	823-1028	9-Apr-2003	003278	KUIZ	--	1	1
49.89 to 49.89	-127.87 to -127.87	840-863	14-Apr-2003	003262	KUIZ	--	1	1
50.83 to 50.83	-126.56 to -126.57	120-130	23-Mar-1980	980-00255-011	RBCM	--	1	1
51.20 to 51.22	-130.04 to -130.07	571-621	15-Oct-2006	010-00193-004	RBCM	--	2	1
53.06	-132.98	1225-1240	21-Mar-1991	991-00332-054	RBCM	--	1	1
53.99 to 54.01	-133.61 to -133.62	490-580	3-Sep-2002	010-00173-002	RBCM	--	6	1
CALIFORNIA: Farallon Islands		1463-1646 [800-900 fm]	2-Sep-1977	183903	CAS	--	1	1
CALIFORNIA: Gulf of Farallones		913-925	16-Dec-1985	96824	CAS	--	7	1